SILICON CHIP

AUGUST 2010
ISSN 1030-2662 08
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- PP255003/01272
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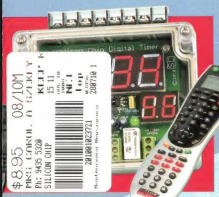

Remote-controlled 1 second - 100 hour Digital Up/Down Timer

We test 30-year-old QUAD Electrostatics:

Do they deserve their legendary reputation?

Ultrasonic Cleaning Tank for Larger Objects

Electrolytic Capacitor Reformer and Tester

hot DEALS TO WARM YOU UP THIS WINTER!

24 -12V DC-DC Converter 10A with Cig In/Out

DC to DC converters are useful for running 12V devices from a 24V supply in a truck or bus. These have switchmode technology for light weight & compact design. Input & output is via cigarette lighter plug & socket.

- Input voltage: 20 - 30VDC
- Output voltage: 13.8VDC
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MP-3352 WAS $69.95

$59.95 SAVE $10.00

4 Port HDMI Switcher with SPDIF/Coaxial Audio Splitter

HDMI integrates audio and video signals, however it results in less than optimal audio output. This 4 port HDMI switcher separates the audio signal from the HDMI interface and transmits it to an amplifier by SPDIF or coaxial (RCA). Remote included.

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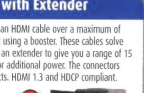
- Dimensions: 155(W) x 70(D) x 23(H)mm

AC-1625

$119.00

HDMI Over Cat 5/6 Extender

Most HDMI over Cat 5/6 extenders available uses two cables for data and signal transmission. This extender only utilises one Cat 5/6 cable reducing the cable costs further on transmission over great distances. Both unshielded twisted pair (UTP) and shielded twisted pair (STP) cables may be used, however shielded is recommended.



AC-1681

$149.00

HDMI Leads with Extender

Normally you can't run an HDMI cable over a maximum of about 5 metres without using a booster. These cables solve this problem by adding an extender to give you a range of 15 or 20m with no need for additional power. The connectors have gold plated contacts. HDMI 1.3 and HDCP compliant.

10m HDMI Lead with Extender - WQ-7403 $99.00 NEW

15m HDMI Lead with Extender - WQ-7408 $139.00

20m HDMI Lead with Extender - WQ-7409 $199.00

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Over the last 20 years this iconic tweeter has found its way into countless OEM hi-fi, home theatre designs and high end speaker kits. Features an aluminium alloy diaphragm with high precision phase shield and butterfly voice coil assembly with Ferro fluid cooling to ensure high power handling. A double chamber also provides a resonant frequency of 850Hz. Add one to your project or give your current speakers a new lease of life.

- Power handling: 100WRMS
- Nominal impedance: 6 ohms

CT-2020

NEW

$69.95

2.4GHz Wireless Headphone USB Transmitter

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- 92dB audio dynamic range
- Operating at 2.4GHz ISM band with 8 selectable channels
- USB transmitter compatible with Windows OS 98SE/Me/2000/XP
- Requires 2 x AA batteries

AA-2035 WAS $99.95

$69.95 SAVE $30.00

Home Theatre Powerboard

Surge protection and filtering is provided to all your home theatre equipment connected to this powerboard as well as current protection via the in-built circuit breaker.

- Provides protection to telephone, data via a network connection, satellite/cable TV and TV aerials.

MS-4024 WAS $64.95

$49.95 SAVE $15.00

MR16 CREE Downlights

Designed for long life, and using the latest in high intensity technology, these MR16 downlights pump out brilliant lumens of white light.

MR16 3 x 2W Cool White

- Lumens: 450
- Colour temperature: White 5000 - 7000k
- Lens:38 degree
- Dimensions: 50(D) x 63(L)mm

ZD-0353 WAS $74.95

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MR16 3 x 2W Warm White

- Lumens: 310
- Colour temp: 2700 - 3500k
- Lens: 38 degree
- Dimensions: 50(Dia) x 63(L)mm

ZD-0354 WAS $74.95

$64.95 SAVE $10.00

Solar Powered LED Bicycle Tail Light

This solar powered tail light is a simple and versatile addition to your night riding equipment. The solar cell charges the two AAA batteries during the day giving you enough power to ride for hours at night. The device uses 4 red LEDs that blink in unison creating an easily visible beacon to cars and trucks.

- Weight: 73g (with batteries)
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ST-3276 WAS $23.95

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Powerboards

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See website for details.

MS-4029 WAS $99.95

$89.95 SAVE $10.00

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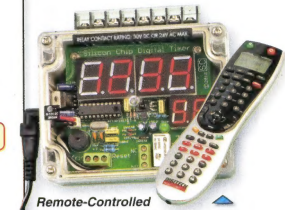

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SILICON CHIP
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SILICON CHIP is published 12 times a year by Silicon Chip Publications Pty Ltd. ACN 003 205 490. ABN 49 003 205 490. All material is copyright ©. No part of this publication may be reproduced without the written consent of the publisher.

Printing: Hannanprint, Noble Park, Victoria.

Distribution: Network Distribution Company.

Subscription rates: $94.50 per year in Australia. For overseas rates, see the order form in this issue.

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ISSN 1030-2662
Recommended and maximum price only.

Publisher's Letter

Big business is driving the push for a carbon price

As most readers will be aware, Australians have two major concerns about energy and energy prices. The largest group would appear to be those who are concerned about the ever-increasing prices for energy, whether it be for electricity, gas, petrol or dieseline. This concern is real and prices are set to go up at an ever-increasing rate, particularly for electricity, because of the lack of new power stations being built and the increasing subsidies being offered to costly renewable energy sources such as wind and solar power.

The other group of Australians who are concerned about energy prices are those who are actively promoting the idea of a "carbon price", particularly now that the Australian government has postponed any immediate action on climate change or an emissions trading scheme (ETS). Probably you think that "green" politicians are behind this push and it is true that there is quite a lot of coverage of the statements made by green groups in the media. However, it is not the greens who are doing most of the pushing – it is big business.

To get an idea of the big business push, you only have to look at "Carbon Expo Australasia 2010" planned for Melbourne in October this year. It is supposedly aimed at "energising the low carbon economy". Now you might think that this is all about "feel good" stuff like installing solar panels on your roof and using waterless toilets but you would be wrong. You only have to look at the list of businesses and business groups involved to have serious misgivings.

A partial list includes the Carbon Markets & Investors Association, Investors Group on Climate Change, Environmental Business Australia, Asia-Pacific Investors Trading Forum, AGL and Bloomberg New Energy Finance. These people are involved because they can see big opportunities to make lots of money if the government can be persuaded to bring in a carbon price or carbon taxes. If either of these do eventuate, energy prices can be expected to go up at an even faster rate.

Last year's CarbonExpo conference was seen as a build-up to the Copenhagen Conference which ended in disarray. The moderator at one of the sessions at CarbonExpo last year was Dr Rajendra Pachauri – he is the same person who claimed that all the Himalayan glaciers would melt within 30 years! Nobody is giving that any credence any more.

You can download the draft program for this year's conference at **http://carbonexpo.com.au/uploads/file/2010/2010DraftProgram2406.pdf** and there you can see that they plan to discuss matters such as "raising finance for low carbon projects from institutional investors", "the state of carbon markets", "Interaction with Asia – issues and opportunities for interacting with Asia as the region transitions to a low-carbon economy", "Carbon capture & storage", biofuels and so on.

None of this is good news for people concerned about increasing energy prices. It is all about looking for new ways to make money – lots of it and government-mandated to boot.

In the session entitled "Australia's role in international action & markets" they will include consideration of: a science update – how has the science shaped up over the last 12 months? What is science's latest view of the emissions reduction imperative? How has science responded to the rise of climate change scepticism – in terms of content & process? Can the carbon market expect increased support from strengthened climate change science? Does this sound like a balanced forum?

It seems that unless there are big changes in the political scene in Australia, we will be paying much, much more for energy in the near future.

Leo Simpson

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See the ScreenScope review in Jan 2010 Silicon Chip!

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Most older homes do not have RCDs fitted

In the letter "Foil Insulation & CFLs", Mr Pierson (Mailbag, June 2010) asked where the RCDs were if it's compulsory to have them fitted. The answer is surprisingly simple. When I last worked in the private maintenance sector 4-5 years ago, it was compulsory for all new houses to have them fitted during construction. Any maintenance work on the electricals in existing houses had to have them fitted if they were not already installed.

There are quite a lot of older houses where no electrical work has been done since that rule has come into effect so that means that those houses do not have RCDs fitted yet. I lost count of the number of RCD units I fitted when in the maintenance sector but there always seemed to be more switchboards to be upgraded.

Brad Coleman,
Brisbane, Qld.

Mains surge suppressors & warranty claims

Over the past year, I have noticed that many of the large retailers of TV sets are advising that either warranties and/or insurance claims will be rejected if you do not use a mains surge suppressor, which of course they have available at a price. I was surprised a few days ago that one such retailer had a surge suppressor sitting on top of each washing machine and when I asked if they included one with each washing machine I was told once again that they were available at additional cost and that unless you used one with the machine, warranties and insurance claims would be rejected.

I have just checked with my insurance company and they say that using a surge suppressor has no effect on their insurance conditions, which are defined as electrical damage caused by lightning either directly on the equipment or due to lightning causing a surge in the mains supply. If a surge in the mains supply is not due to lightning (which has to be determined by a technician or by meteorological records), they advise you to contact your electricity supplier.

Since all TV sets now use either LCD or plasma screens and most washing machines are electronically controlled, I wonder why the manufacturers don't build in surge suppressors if mains surges are such a problem. I am inclined to think that it may have more to do with adding to the retailers sales (like extended warranty).

I wonder what other readers have found when shopping for home appliances and whether there are some valid warranty or insurance claims that have been rejected because no mains surge suppressor was used.

R. Sanders,
Kiama, NSW.

Comment: any retailer pushing the sale of mains surge suppressors on the grounds of possible warranty claim rejections would appear to be on shaky legal ground.

As a first point, you could argue that the dealers are selling equipment which they know is not of "merchantable quality" if there is a danger that mains surges will blow it. All electronic equipment intended for use with the 230VAC mains should be able to withstand normal surges and will typically have MOVs (metal oxide varistors) in

All fluorescent tubes contain mercury

I read your article entitled "Slash Your Factory/Office Lighting Bills" on the May 2010 issue with interest.

However, on page 19 you indicated with the picture of the NEC fluorescent tube that the absence of the "HG" (mercury) marking on the quad-phosphor means that no mercury is present in this new tube. This appears to be misleading and requires further clarification.

I believe that HG on the product is defined as "High Grade" on the NEC fluorescent tube and does not indicate mercury (Hg). In the Periodic Table, mercury is specified as Hg where the "g" is lower case (small letter alphabet) as opposed to upper case (capital letter alphabet).

I picked up one tube to analyse the labelling that you mentioned. On the paper sleeve packing of the NEC fluorescent tube, it stated HG as "High Grade" and not as mercury. HG is Tri-Phosphor and the HGX is designed to be used for electronic ballast units. X series is Quad-Phosphor but note that both X and HG has a 5000K colour temperature, even though one is Tri-Phosphor and the other is a Quad-Phosphor type.

I am yet to come across a fluorescent tube that has no mercury although modern fluorescent tubes do contain negligible amounts. A manufacturer can produce a mercury-free fluorescent tube by substituting aluminium trichloride which when energised produces a plasma discharge that emits ultraviolet and visible radiation. Phosphor, in the form of a particulate layer or a gas, converts the ultraviolet into visible light. So it can be done but the cost involved will be very much higher.

Michael Ong,
Wembley, WA.

Comment: you are quite correct. The reference to mercury in that caption is a mistake.

Possible vintage radio restoration project

We found this old HF two-way radio at the bottom of the Torrens River in Adelaide near the Southwark Brewery. The river was dry during summer, the second time in 40 years.

A 2.178MHz crystal was found inside and was the only thing still working (made in the UK). Note the valve still inside, although air has entered the tube. We couldn't find any identifying markings on the radio. Any reader feedback would be good. We are thinking it would be a good restoration project. HaHa.

Dom Martucci,
Adelaide, SA.

Comment: is there any reader out there who feels like rising to the challenge? Er, perhaps not.

their power supplies to provide protection.

Second, if there is such a condition in the warranty, the dealer should be able to refer you to it. Third, it is just possible that some of the extended warranties sold by dealers do have such a condition but again, it would need to be highlighted to the potential customer.

Having said that, there is nothing wrong with connecting valuable appliances via a mains surge suppressor to provide extra protection. However, we would be wary about using them with washing machines as their induction motors have high surge currents in normal use and these may trip any current overload device in the surge suppressor unit.

Finally, while we understand that retailers often make very little margin on major electrical and electronic equipment and therefore try to make more profit by selling all sorts of accessories, there should be no compulsion on the customer to purchase these devices.

Switchmode supplies cause mains waveform distortion

Your article on electronic ballasts for fluorescent lighting (SILICON CHIP, May 2010) did not mention the possible introduction of harmonics to the mains. I work in an office with a large number of PCs fed from a large 3-phase inverter. Some time ago, an electrician working

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Mailbag: continued

in the switchboard feeding the PCs brushed up against the neutral wire and noticed that it was warm. A current meter showed that it was carrying about 100A; more than any of the Active phases. The electrician could not explain this but fixed the problem with a larger gauge Neutral wire.

Later, I found out that this large Neutral current was caused by the third harmonic distortions created by the PCs' switchmode power supplies. In a balanced 3-phase system, the fundamental frequencies will cancel each other out in the Neutral. However the third harmonics will add together to produce a significant Neutral current.

I do not believe that this is well-known and may be a problem in older 3-phase installations where the Neutral wire would sometimes be smaller than the Active phase wires.

It would be interesting if you were able to measure the mains distortion produced by electronic ballasts, since if it were significant, it could present a problem in a large installation with the lighting spread over three phases.

Mark Baker,
South Perth, WA.

Comment: most switchmode power supplies do cause considerable distortion of the mains waveform because they take their current from the peak of the waveform. That is why the peaks of the sinewave are often clipped.

However, our current waveform for the electronic ballast shows a reasonable sinewave (see Fig.2, page 14, May 2010), albeit with a relatively small amplitude higher harmonic. We therefore assume that our sample electronic ballast luminaire does have power factor correction, in that it draws its power over the whole mains cycle rather than just at the peaks of the waveform.

We do not have any easy way of measuring the distortion caused by a single electronic ballast.

Queensland electrical licensing regulations are full of legalese

I have read some readers comments in the Mailbag pages about electrical licensing in Queensland and thought that you might be interested in my experience. My licence was due for renewal in February and I have decided not to bother. I am supposed to do a test based on rules which I refuse to have any thing to do with, on principle. The skills maintenance course has nothing to do with electrical skills; it is to promote a rules-based profession.

The documents that you have to read to do the test are called: Electrical Safety Regulation 2002, Electrical Safety Act 2002, Code Of Practice Working Near Live Parts, and Code Of Practice Electrical Work. Now if these documents were written for the general public who wanted to do thir own electrical work then it would be fine but not for people who are supposed to be highly trained.

Standards and wiring rules etc have been around for a long time but these were written by electrical engineers and I would recommend them to anyone who wants to do electrical work. These new ones I believe are written by lawyers and by the many changes and revisions made to them since 2002, when they were first printed, it seems to me that they make these rules as they go along. As an example, on page 31 of the code of practice it says: "work" on an electric motor means work on the electric motor that would be electric work if the electric motor were electrical equipment". The part that really disgusts me though are all the penalty points.

All the Government departments that I have contacted, to bring this 600 pages of useless information to their attention, seem to have missed the point. I am sure that they can't bring themselves to believe that there are laws that are fixed for all time, that don't have to be tested in court and were not created by them. Real tradesmen only use electrical laws such as Ohm's law. If you have a complete understanding of these laws and how to apply them, it enables you to carry out electrical work properly and safely and neatly; in other words, in a tradesman-like manner.

To do all this you have to be properly trained and I believe that is why the government has resorted to the threats of heavy fines and even jail to try to force so called "electrical workers" to do their job correctly.

I can remember doing some electrical work that was not as straightforward as one might think and which took a bit of mathematics. When I had finished, I asked the apprentice training with me if he could tell me why we had to do what we did. Straight away he quoted some rule numbers which may have been correct for all I know but

when I asked what electrical laws were involved he had no idea. I should have known something was wrong then.

If we do go in for nuclear power stations, then I hope that they don't use these electrical workers to wire them up!

Ron Groves,
Cooloola Cove, Qld.

Free organ to a good home

I have an Electone electronic organ to give away. It works but the key system needs some maintenance. It is large and heavy and will need a ute or truck and two people to move it.

Please phone 0402 061 576 for further details.

Bryan Maher,
Springfield, NSW.

DAB+ to FM/AM converter could be desirable

I think that you were a bit hasty in dismissing the suggestion from PM, Karabar, NSW (Ask SILICON CHIP, July 2010) for a DAB+ to FM/AM converter.

It is true that FM quality at its best can be superior to digital broadcasts in terms of detail and resolution. But this comparison is only valid where a high strength FM signal can be received.

At my own home I can only receive a small number of FM stations, with weak signals that are prone to fading, giving noisy audio which often drops back into mono. This is despite having a roof-mounted FM aerial and a state-of-the-art analog FM tuner.

This all changed recently when I was given an iRiver B30 portable media player as a birthday present. This superb little device is the same size as an iPhone, yet boasts something which the iPhone cannot match – a built

Keep that VCR in use

With the impending demise of analog TV, there must be many people who, like me, are not fussed about High Definition and have perfectly good CRT TVs with SD STBs. I also have a nearly-new VCR with an analog tuner which will become useless.

Here is a suggestion. Don't spend $500 on a new video recorder. Obtain a second digital STB. SD boxes are available cheaply on eBay and will become even cheaper as people move to HD. Connect the composite video output to the VCR's AV input. Now you can watch one channel while recording another and also time-record. The only thing you cannot do is switch channels in the same recording session; a small price to pay, I think. Note also that the antenna connection to the TV and the VCR can now be removed. This will cut down on cables and amplifiers in the circuit.

Graham Hunt,
Mt. Martha, Vic.

Comment: good suggestion Graham, although for only a little extra money you can get the same advantage with an HDTV STB (around $80) and then you can also record programs broadcast on the HD stations.

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Mailbag: continued

Should battery-operated devices have a Star energy rating?

In the Mailbag pages of the October 2009 issue, I wrote to you questioning DAB+. Then in May 2010, I bit the bullet and replaced the FM radio on my bus with a Kaiser Baas Digital radio, mainly because of the new commercial-free stations ZOO and WSFM plus. All I can say is I have wasted my money.

A number of my bus driver colleagues have also gone digital (purchasing Kaiser Baas, Pure and Roberts radios) and they are also questioning the benefits of digital other than the new stations on offer. When I wrote in, I said I had problems with FM around Clovelly, Bronte and Maroubra Beaches. As far as digital goes, these areas are "digital-deaf" zones.

I count myself lucky as I generally listen to WS FM so when in these areas, I flick off DAB back to FM. I get some static over the audio but it is far more pleasing to the ear than deathly silence.

I feel sorry for the AM listeners who have gone digital with the promise of better clarity and performance. None of the portable units offer AM, so if they are listening to 2CH or 2SM, they've got nowhere to go when it mutes.

In December 2009, Alan Hughes from WA commented on what I had to say, questioned DAB+ for their choice of Martin Place to showcase the new product and suggested I go to a local electrical retailer, as I should not have the same problems as I experienced in Martin Place. I don't want this to become a tit for tat but that's fine if you want the radio for home, which means the radio is stationary.

As a bus driver, my radio listening pleasure is on the move and it is extremely annoying when you are stopped at the intersection of Elizabeth and Park streets in the Sydney CBD with perfect reception only to totally lose it when a truck or another bus pulls up beside you at the traffic lights. This happens in so many locations. To paraphrase Alan "DAB+ is either perfect or non-existent". And that's exactly what is happening in reality.

Another gripe with the new digital radios is how "energy inefficient" they are. My colleagues all say they now have to recharge batteries, as do I, every two days. Our old dial radios would go for weeks before recharging was required.

My radio is on for around 8-9 hours a day and I am using the same four 2700mA NiMH batteries that were in my old radio. I measured the current drain with a comfortable listening level and in the old radio it was around 40mA, while the new radio draws a huge 160mA. With the 20hr rate of my batteries being 135mA, it's no wonder I am only managing to get two working days out of them.

Simon Kareh,
Penshurst, NSW.

in DAB+ receiver. The audio output from this is of very high quality and it makes a truly great front-end for my NAD amplifier and Acoustic Research speakers.

The B30 tuned in a total of 43 digital stations within one minute of being first switched on and reception on all of these is perfect. This is an impressive feat when you consider this is all achieved using a tiny 6-inch telescopic antenna! Quite a few of the stations which I now listen to regularly on the B30 are only available on digital and not on FM.

Your statement in your reply that "most DAB+ programs . . . can be received perfectly well . . . on standard AM/FM radios" is not really true and I am sure that many readers who like me have less than perfect FM reception would be interested in a DAB+ to AM/FM converter.

Those readers who enjoy the vintage radio section in each month's issue are another potential user group. With older valve sets which are restricted to AM reception, the converter would allow access to both digitally broadcast FM programs and digital-only programs, as well as extending the "listening life" of these sets beyond the time at which analog disappears. Yes, some of the frequency response would be lost due to AM reception but the point in this case is to enjoy the program material via a classic "valve sound" on a genuine old radio set.

Keith Cusson,
Mount Dandenong, Vic.

Comment: we will reconsider the project concept. In the meantime, we have had a high quality DAB+/FM tuner under development for some time. We hope to publish the first article for this project in the September issue of Silicon Chip.

Handy tip on USB Electrocardiograph

In the Ask Silicon Chip pages of the June 2010 issue, J. D. wrote about the USB-ECG project, regarding the sourcing of a capacitor.

When testing the device, I suggest they use a "Lead 2" configuration, ie, Electrode 1 to left leg, Electrode 2 to the right arm. The other lead groups can typically give very small amplitudes; Lead 2 often shows a clearer wave form. Hope this is of help.

Dr Michael Jensen.
Sippy Downs, Qld.

New site for DDS VFO software

The DDS VFO design of mine was published in Silicon Chip in March 2008. Due to the demise of Geocities and their hosted websites, the information on where readers can obtain downloads of the DDS VFO software and updates mentioned in that article is no longer valid.

I have a new website now where this information can be downloaded, as well as other details for using the DDS VFO with different IF offsets etc at www.zl2pd.com

Andrew Woodfield, ZL2PD,
Christchurch, New Zealand.

Accusations of Photoshop manipulation

The pictures of Sanctuary Cove in the July 2010 issue really mystified me. Both pictures show enclosed pontoon

bays full of boats, a fine achievement especially if the small problem of opening and closing the "closure" to allow the ingress and egress of the boats within the closure has been solved. I was so impressed I couldn't resist the urge to go direct to Google Earth to see a closer view for myself. Where were those opening gates to the bays? How did they achieve it?

What a shock. Sanctuary Cove looks totally different on Google Earth. It just looks like a marina should with traditional bays allowing the boats access everywhere. Some big changes had somehow occurred within the computers of SILICON CHIP.

So after a lifetime of seeing/reading/enjoying a really professional magazine, I now suspect someone has white-anted this fine establishment with a little too much Photoshop. It may have escaped your notice but making a glaring error like this in a top technical magazine we all highly regard is childish. It is probably a youngster in the system who doesn't understand.

Integrity is more important than a cheap shot like filling a Marina up with more boats and bays than it could ever hold. As you have named the company, its location and shown it on your cover and on page 11 in a grossly altered form, it would not be unfair of Sanctuary Cove to ask you for an apology.

The original picture of the marina is fine, so why was it even considered for alteration?

Bruce Wilson,
Warriewood, NSW.

Comment: we deny your accusations. Why would we take the trouble to extensively modify the photos? They were taken by helicopter during the show and were supplied by Kevin Poulter. We asked him to comment and here is his response:

"Wish he'd go to a boat show instead of sending a detailed salvo with no basis whatsoever!

The aerial photos of the Sanctuary Cove Boat Show are not modified in any way, proving that the major boat shows around Australia are an incredible logistical effort. The existing jetties are extensively supplemented by a great number of temporary ones, most being the floating type to give full public access.

I also understand that many of the permanent boats moored there are moved for the duration of the show. It's probably the biggest boat show in the Southern Hemisphere. During that time, the huge density of boats has no resemblance to Google Earth photos, which can be years old.

If Bruce is impressed how a marina can be converted for a show just for a few days, he would be gob-smacked at the size of the temporary electronics and accessories tent halls".

Kevin Poulter,
Dingley, Vic.

SC

Solar Power

It is often said that solar power plants can't 'do baseload' – that they only provide power when the sun shines. Not so: Richard Keech and Matthew Wright* explain how solar thermal plants work and how the Spanish now get solar power around the clock using advances in thermal storage.

The talk about climate change has seen a renewed interest in power. After all, electricity generation is the largest single man-made source of greenhouse gas emissions, mostly from the burning of fossil fuels, usually coal or gas.

But sustainable alternatives exist – one of the most exciting is Concentrating Solar Thermal (CST) power [sometimes called Concentrating Solar Power (CSP)].

Traditionally, solar electricity generation has been only when the sun shines. Hence the great appeal of new CST plants which can store their heat and generate power even at night.

Solar resource

At ground level, the power of the Sun on a one meter square surface, at right angles to the Sun's rays is about 1kW.

Excluding cloud effects, this gives an average of about 6kWh/day for every square meter in sunlight. If you do the numbers this represents a phenomenally large resource.

Australia's total current electrical peak generation capacity (about 49GW) is equivalent to what falls as sunlight on an area of about 8km x 8km (at noon at Southern Australian latitudes) or about 0.001% of the Australian landmass.

When you take into account typical sunlight patterns, typical plant efficiency and layout, you would still need less than 0.05% of Australia's land area to generate equivalent power.

To put the required land area in perspective, it would fit six times into Anna Creek, Australia's largest cattle station. It is clear that in a country like Australia, the solar resource greatly exceeds our energy needs.

CST technologies

Before considering how solar plants can run at night, let's review the underlying technology of CST. They have in common the basic principle

* Executive Director, Beyond Zero Emissions

24/7

Trough mirrors from a Spanish solar power plant (BZE photo).

of capturing solar energy to heat water to generate steam (see box below'not all steamed up'). This steam powers a turbine, which in turn spins an electric generator to create AC power. From the point at which the steam is generated, a CST plant is similar to coal, gas or nuclear in its operating principle.

A solar plant is distinguished by how that steam is generated in the first place. To capture solar energy, mirrors reflect the sun's rays to a central collection point. Different arrangements of mirrors exist. Broadly speaking these are: troughs, power towers, linear fresnel and dishes.

Trough technology

In a trough configuration, long lines of mirrors with a parabolic cross section focus solar radiation on a pipe. A fluid pumped through the pipe to pick up the solar energy is heated to around 400°C. The fluid is usually a high-grade synthetic oil which does not boil or degrade at high temperatures. These oils are only suitable up to about 400°C.

Trough technology is the most proven CST design. The largest solar generation facility in the world, SEGS (a set of nine plants near Kramer Junction in the Mojave desert California), uses troughs. Jointly they have a capacity of 354MW.

In a trough plant, the mirrors rotate around their long (North-South) axis to track the Sun during the day. Because they remain horizontal and so don't track the Sun's elevation, trough mirrors are most effective close to the equator. At the latitudes of Southern Australia, trough mirrors are only about half as effective as a mirror that can track the sun. This is due to the projection effect (see 'capturing the sun efficiently').

Linear Fresnel

The curved mirror structures of a trough plant are very expensive. A less-expensive variant on the trough mirror configuration is a Linear Fresnel (pronounced 'frenell'). These systems use long, near-flat mirrors close to the ground to make an optical approximation of a parabolic trough, without the structural complexity.

Not all steamed up

The main technology used in present-day electrical generation is steam turbines. However it's worth noting that some solar power plants are being built which don't use steam.

Some are using concentrating photovoltaic and some use Stirling heat engines. Neither of these technologies are currently able to provide effective energy storage.

A Linear Fresnel assembly (from Areva Solar – formerly Ausra.
http://en.wikipedia.org/wiki/File:Fresnel_reflectors_ausra.jpg)

The systems from Biotec Novasol (owned by Australian company Transfield) and Areva Solar (formerly Australian company Ausra) both have relatively low operating temperatures (of around 290°C) and therefore there is no viable commercially available storage method.

Linear Fresnel companies are moving to higher temperatures and pressures. Mann Ferrestel/Solar Power Group are offering 450°C in a Linear Fresnel configuration.

Dish technology

Mirrors in a dish configuration are effective at concentrating the sun and track the sun in two axes. Previously they've been expensive and not often used in production solar energy plants.

Australia's first solar thermal power plant was a dish-based facility at White Cliffs in NSW which operated from 1981 to 1996. This was a 25kW plant for an off-grid community and was developed by the ANU.

The ANU has also developed the world's biggest mass production solar dish system. The ANU SG4, a fourth-generation dish is now ready for mass production.

Their innovative manufacturing system involves a 'factory in the field'. It is built in the field on a very accurate jig, instead of adjusting the dish after it has been manufactured.

Tower systems

Tower-based systems use a large field of near-flat, independently controlled mirrors called heliostats to focus sunlight on a central receiver at the top of a tower.

Tower configurations can scale up to configurations involving many hundreds or even thousands of mirrors. This gives towers the greatest capacity to concentrate the sun's rays, leading to higher operating temperatures.

Heliostats are spaced to ensure they don't overshadow each other. A modern tower-based solar plant would typically pass a fluid through the receiver to be heated up to about 570°C (and in future up to about 650°C). At this temperature, electrical generation can be more efficient and cheaper than that from a trough configuration which heats to about 400°C.

The turbines required in conjunction with a tower are the same as those used in coal-fired plants, whereas the turbine technology required for lower-temperature operation is considerably more expensive because of the much lower economies of scale.

Heat Storage

In November 2008 the 50MW Andasol 1 CST plant near Granada in southern Spain started feeding power to the grid. What was most interesting about this plant was its ability to supply power to the grid around the clock using a system of heat storage in tanks of molten salt.

The adjacent Andasol 2 plant has since come online and doubled the capacity to 100MW. Andasol 3 is under construction now, with Andasol 4 in planning.

These CST plants are each rated as having 7.5 hours of thermal storage. This number represents the storage when running at the full rated output of the plant.

Operators can choose to run at lower output for longer periods, giving the plant round-the-clock generating potential.

Molten salt

The use of molten salt as a storage medium has been proven for some time (the French had a prototype test plant in the early 1980s). The US Department of Energy had a commercial

An SG4 dish mirror from ANU in Canberra (BZE photo)

Capturing the sun efficiently

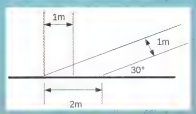
Heliostat mirrors track the sun in two axes which makes them more efficient than horizontal trough mirrors, especially in winter and when sited further from the equator.

Compared with a flat, which gives the best sun tracking, a trough mirror captures about 70% less energy in winter at temperate latitudes because of the low angle of the sun. The reduction in collection capacity is called the *projection effect*.

Solar engineers use the term *insolation* to describe the measurement of received solar energy and Direct Normal Insolance (DNI) to describe the solar energy available to solar plant which track the sun in two planes on axes.

For commercially-energised solar, the minimum is less than to the projection effect) and measured as Global Horizontal Insolance (GHI).

DNI and GHI are often confused and this confusion can cause misinformed assessments suggesting low performance for solar thermal



systems which in fact will operate best (on direct beam radiation without significant projection effect loss and power) perform very well in the high climatic bands of year round level of higher latitudes.

The PS10 power tower near Seville in Spain (BZE picture)

demonstration plant called Solar Two operating with storage in the 1990s. The salt mixture generally used is 40% Potassium Nitrate and 60% Sodium Nitrate.

The salt, which is chemically very close to fertilizer, has a number of properties that make it suitable:

- It is stable as a liquid over a large temperature range
- It is reasonably priced
- It is non-corrosive
- It can be used in unpressurised, insulated carbon steel vessels.

In operation, salt is pumped between two large tanks – one hot and the other (notionally) cold. The salt mixture has a freezing point of about 225°C (depending on formulation) and needs to be kept in liquid form at all times.

So the 'cold' tank is operated at about 285°C, while the hot tank can hold a temperature of 400°C or higher. There is no material phase change involved in the use of the salt.

Andasol is a trough plant. When its mirrors are collecting sunlight, it heats a synthetic oil. In turn this is passed through a heat exchanger to re-heat the 'cold' salt which is pumped back into the hot tank.

When electrical generation is required, the liquid salt is pumped through a steam generator to drive a conventional Rankine-cycle steam turbine and then into the 'cold' tank.

Andasol uses Siemens SST-700 turbines, which are widely used in the power industry (www.energy.siemens.com/hq/en/power-generation/steam-turbines/sst-700.htm).

Molten salt tanks at Andasol (picture: BZE)

Power towers and storage

Since Andasol was commissioned, attention is on the Gemasolar (pronounced 'hemasolar') Solar Tres project near Seville in Southern Spain.

Solar Tres, currently under con-

The rotor of a Siemens SST-700 turbine (Photo: Siemens).

struction, is a power tower rated at 17MW with 15 hours storage. When commissioned it will be the first commercial power tower with storage and will take advantage of the higher operating efficiencies possible using this configuration.

The salt will be heated to about 565°C. At these temperatures, each MWh of energy generated requires about 25 tonnes of salt.

Plants operating at lower temperatures require proportionally more salt per unit of energy stored; with an upper temperature of 400°C, the energy stored is about 1MWh per 75 tonnes of salt.

Changing the relative sizing of the mirrors, storage and turbine allows for different balance between maximum power and energy storage.

In the case of Solar Tres, with 15 hours of storage at full power, gives true baseload capacity.

The trade off between power and storage is shown below. These levels of average utilisation (about 75%) compare favourably with Australian baseload coal-fired power plants. On average NSW coal plants operate at an average 63% of rated capacity.

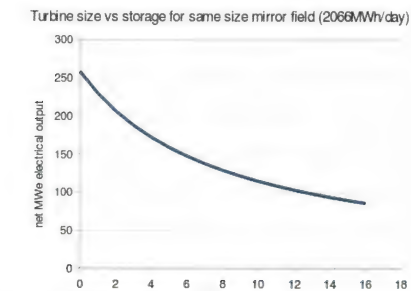
Bad weather backup

To deal with the inevitable periods of cloud, it will be necessary to have some form of backup energy source. Future solar plants could, for example, utilise a renewable, low-value biofuel.

Once backup is incorporated, a solar plant could provide the year-round dependability required to underpin a modern energy economy.

Backup is of most benefit when a plant is installed on an isolated grid.

However, on larger grids and grids integrated with wind power, zero or very minimal co-firing with biomass, storage hydro or pumped storage hydro would be required.



Trading of power and storage (source: BZE Solar Flagships).

Solar Thermal in the US

Spain has taken the early lead with the first commercial CST-with-storage plants.

However in the USA, the Bureau of Land Management (BLM) has received over 100,000MW of plant approval applications on BLM land in six states alone.

Half of all these applications are for tower-type systems with much of those using molten salt as a working fluid and 24-hour dispatch storage media.

This year, according to the head of the SEIA, Fred Morse and head of Sandia National Laboratories, Thomas Mancini, it is expected that around 11 large scale solar thermal plants will be started.

Each of these projects will take less than two years to build. Contrast this with 12-24 months for wind plants, 5-7 years for coal plants and 7.5-19 years for nuclear plants.

Costs

Currently first-of-a-kind, medium-scale solar plants with storage are being built in the US which can generate power at about 20 cents per kWh.

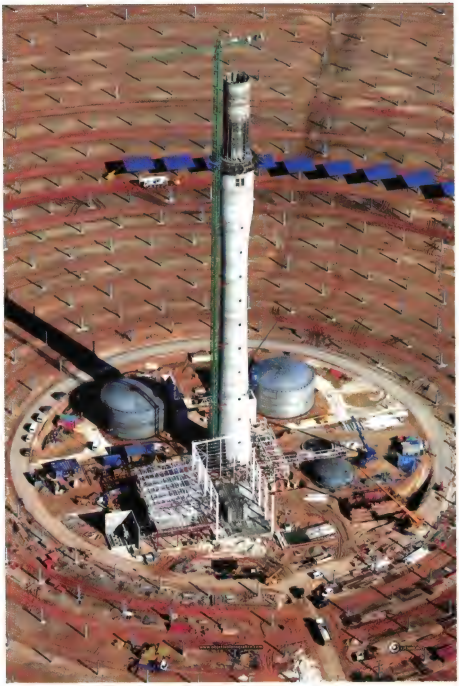
New technologies always follow a cost-reduction curve once they mature and economies of scale are realised.

Research suggests that when the installed capacity expands by a further 8700MW, CST plants could reach cost parity with new coal and gas plants, providing power at around 5c per kWh.

Re-powering Australia

Australia's entire energy needs could conceivably be met with a 60:40 mix of Spanish-style solar thermal and wind.

Other technologies, such as geothermal and wave power, show promise



The Gemasolar Solar Tres plant under construction in February 2010 (photo: Torresol Energy).

but solar thermal and wind can be deployed at scale today and could be sufficient to entirely power the Australian electricity grid.

This research has been done as part of the Zero Carbon Australia 2020 plan at www.zerocarbonplan.org.

Conclusion

The Spanish are really onto something. Using technology pioneered by the French and Americans, they have demolished the myth that you can't do baseload power with renewable energy.

There are now two companies, Torresol from Spain and Solar Reserve from the USA, with commercially available solar power system with storage.

These systems' operating characteristics compare well with conventional coal, nuclear or gas combined cycle plant.

We no longer have to wait for years of research to bear fruit and we no longer have any excuse to delay.

The future of renewable energy seems bright indeed. SC

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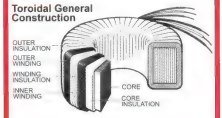

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EXPERIMENTAL TUBELESS COLOUR TELEVISION RECEIVER

Because of problems associated with the shadow mask tube now used in domestic colour television sets, electronics engineers are continually exploring other approaches. In Japan, engineers of the Sony Corporation are conducting experiments designed to examine problems likely to arise should light emitting diodes be developed to the stage where light output is sufficient for this application.

As a first step, they have built a colour receiver in which the picture is presented on a matrix of light bulbs. This has resulted in a 78,000 miniature 8ft diagonal, using 78,000 miniature light bulbs, 260 SCRs, 4,000 transistors and a power supply which delivers 300A at 30V. The most important innovation in the system is the conversion of standard video signals into pulses for digitally scanning the X-Y matrix with pulse-width modulated signals.

Sony's colour video panel uses light bulbs arranged in a matrix with 260 horizontal lines of 300 lamps each. The lines are staggered to form red-green-blue colour trios spanning two lines.

A television signal is picked up by a standard receiver and the three colour signals are separated from the audio and synchronisation signals.

The colour signals are sampled to generate pulse-width modulated signals with a constant amplitude but a width proportional to the intensity of each colour signal.

For zero intensity (black), the pulses have zero width. For maximum intensity, the pulses are about 100 microseconds wide. The eye integrates the light and perceives lamps that stay on longer as being brighter than lamps on for less time.

Each output transistor in the X channels is operated at a duty cycle of 0 to 75 per cent. These transistors are operated in the pwm mode at a period of twice the horizontal-line time, with the peak currents of the lamps. For this type of operation, the dissipation of the output transistors in the various channels runs in the range of 100 to 300 milliwatts. Neither the current value nor dissipation is much of a problem; the output transistors in the X channels are operated without heat sinks.

The vertical synchronisation pulses start the display at the top. The horizontal lines are turned on, one at a time, by SCRs connected to each line. The horizontal lines stay on for twice the horizontal scan time.

The 78,000 ordinary tungsten pilot lights form 26,000 red-green-blue trios. Though this is less than 1/10 the number of elements on a conventional colour tube, the picture resolution isn't degraded as much as one might think. In the X-Y video panel, completely independent information is injected into each light bulb. In a picture tube, the electro-beam spot is ordinarily large enough to cover three or four of the holes in the shadow mask. Furthermore, in the tube, reproduction of areas with white-peak brightness is degraded by increases in spot size, which cause the phenomenon known as blooming. However, blooming cannot occur in the colour video panel because each bulb gets information independently from its neighbours. This keeps the picture surprisingly sharp.

Another advantage over the tube is that colours cannot be misregistered. In the tube, beams are aimed at colours and may misconverge. But in the video panel, signals are fed directly to colours and thus always stay in proper relationship.

On the other hand, the picture produced by the panel's 26,000 trios, is not as detailed as that of the picture tube, which has 350,000 elements. Interlaced scan cannot be used, because there are only 260 horizontal lines. However, non-interlaced scan can provide reception that is satisfactory even though it is not up to normal standards. Non-interlaced scan is used in the small Sony video tape recorder designed for home use.

The video signal must be sampled to convert it to the multichannel signals required to drive the colour video panel. With 300 lamps in each horizontal line, picture information from the original signal for any one lamp must be sampled within an interval

This picture of a portion of the Sony video panel clearly shows the dot structure created by the light bulbs. The panel uses incandescent lamps with filter caps for the red-green-blue trios. The panel measures about 6ft. by 5ft., giving a diagonal of about 8ft. (This picture reproduced from "Electronics", Vol. 41, No. 8.)

For those who thought flat-screen TV was a recent innovation, check out this article from Electronics Australia (sorry, reproduction wasn't quite as good then!). And now look at the date: 42 years ago this month . . . and it was all done with 78,000 tungsten pilot globes!

less than 1/300 the horizontal period of 63.5uS. The sampling interval is thus 0.01 to 0.1uS.

The red lamps have a DC rating of 2V and 30mA. Green lamps have a DC rating of 1.5V and 30mA. Blue lamps have a DC rating of 1.5V and 70mA. However, the lamps are not used at their rated current and voltage levels.

The lamps are used for only a maximum duty cycle of 0.7 per cent — at 30V for 100uS maximum out of each 16.7mS. The peak current for the red lamps is 400mA, for the green lamps 600mA, and for the blue lamps 1A.

The pwm signal can be obtained with simple circuits. The amplifiers are saturating transistor switches that are either in saturation or off, so that gain doesn't vary between channels. Because amplifier output efficiency approaches 100 per cent and collector dissipation is low, there is a good chance that circuits can be integrated.

The lamp current is not constant while the pulse is applied. Lamp voltage, as noted, is constant. The lamp current varies during the 10uS or so that it takes for the lamp to reach steady state, but then is approximately constant. After the lamp is turned off, brightness fades rapidly, but a faint afterglow continues for several milliseconds. Light output falls to zero, though, before the end of the frame, which lasts 16.7mS.

These rise and decay characteristics are nonlinear, and are different for each colour. If uncorrected, these differences would unbalance the colour signals. Correction is applied by simple curve-shaping circuits with diodes to give segment approximation of desired characteristics in the three video amplifiers. Circuits of this type have long been used in analog computers as curve generators, and in television cameras for gamma correction.

Anyone who has had experience with tungsten filament light sources might worry that the lamp's light decays too slowly for this application. But this isn't a problem for the miniature lamps of the type used for dial lights. Luminance decay of these lamps is sufficiently short compared with the 16.7mS vertical scanning period of the television signal, because small filaments cool quickly.

One hope for future display panels is a p-n light-emitting junction. If an electroluminescent diode could now be produced more cheaply than the lamp plus a diode, perhaps by LSI (large scale integration) techniques, and made to produce the desired red-green-blue tungsten filament lamps. But today's diodes aren't bright enough, and blue luminescent diodes can't yet be produced. Also, costs are still high and yields poor. ("Electronics," Vol 41, No. 8.)

SONY DEVELOP SINGLE-GUN COLOUR TUBE

As well as their interest in the matrix type screen presentation for colour TV outlined in the previous article, the Sony Corporation is also carrying out considerable research and development work on improved forms of colour TV tube of the conventional kind. This description of a new type of colour tube appeared in recent issues of "Electronics Weekly." (May 1 and 8, 1968.)

Considerable interest has been aroused by the recent announcement of a new type of three-beam single-gun colour TV display tube by the Sony Corporation of Japan.

The new display tube — called the "Trinitron" — is claimed to be based on entirely different concepts to either the Shadowmask or Chromatron colour display tubes.

It is being claimed that the new techniques provide brighter pictures while the single gun may appreciably reduce manufacturing costs.

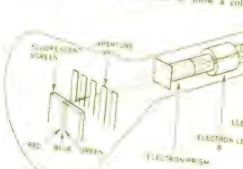
According to Sony engineers, the Trinitron system employs a single electron gun that emits three electron beams simultaneously, making them converge on systems of two large diameter electron lenses and two electron prisms.

The large diameter of these lenses is said to result in much greater brightness and picture sharpness.

A colour separation technique known as "aperture grill" has been developed with the co-operation of the Dainippon Screen Manufacturing Company of Kyoto. This aperture is said to ensure better transparency and so help improve picture brightness.

It is also claimed that the new display system is relatively simple to set up and converge.

Some reports indicate that Sony plan to show a colour receiver using a



13-inch Trinitron tube in New York in late May and to be preparing to market the receiver in Japan later this year, and in the United States in 1969.

The simplified receiver using the Trinitron is expected to be marketed in Japan for a little over £125. Sony is reported to have applied for more than 100 patents covering the new tube.

The accompanying diagram shows the main features of the Trinitron tube. Three beams are emitted from the single gun containing five grids, with three cathodes aligned directly behind three holes in the first grid. At the exit from the gun is a set of electrostatic convergence plates or prism. No convergence yoke is used.

It is claimed that the system operates with considerably greater beam current than the Shadowmask tube.

Sony also claim that greater brightness results from the use of the aperture grill in front of the colour strips on the faceplate. The aperture grill expands in the vertical direction, maintaining registration.

A 13-inch colour TV receiver using the Trinitron is said to consume only 65 watts of power.

No details of the cost of the new display tubes have yet been given, and Sony apparently intend to continue building sets having Chromatron type tubes.

EDITOR'S NOTE From the foregoing, and the diagram, it would appear that the basic differences between this tube and the conventional Shadowmask tube are that the phosphor is laid down in vertical parallel lines, with the red, blue and green phosphors alternating and that the Shadowmask is replaced by a vertical grille, so placed that it is at the focal point of the three converging beams, and at the right distance from the phosphor for the three beams to spread the right amount to fall on their correct phosphors. Expansion of the grill caused by temperature difference is mainly in the vertical direction, so that beam registration is not significantly affected.

The snippet on the right side of this page also makes very
interesting reading: they were talking about the fore-runner to one of the most
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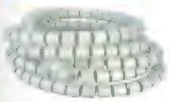

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dick smith

Talk to the Techxperts

QUAD hifi gear: how it stacks up 30 years on

Quad introduced the world's first full-range electrostatic speakers in 1957. Our photo shows two ESL63 second generation units from the early 1980s, together with a Quad CD player, FM tuner, stereo preamplifier and 100W/channel stereo power amplifier.

Thirty years ago, any hifi enthusiast worthy of the name would have hocked his soul for a Quad hifi system with electrostatic loudspeakers. But how does the Quad gear of that era stack up against modern hifi gear?

QUAD WAS A NAME revered by those who were into hifi sound during the 1950s, '60s, '70s and '80s. Founded in the UK in 1936, they made a name for themselves building high-quality power amplifiers, speakers and other audio gear. They introduced the world's first full-range electrostatic speakers in 1957.

So when our very own Serviceman told us he had inherited a Quad electrostatic system from a relative in the UK and asked if would we like to listen to it, we jumped at the opportunity. At the forefront of our minds was the question: how would the legendary Quad system compare to the best audio equipment available today? Did it deserve its reputation?

Line-up and appearance

The system consists of seven components: two Quad ESL63 electrostatic loudspeakers, one Quad "L-ite" subwoofer, the amplifier/preamplifier/FM tuner group and a Quad 66 CD player (a relatively recent addition).

The ESL63s are second-generation electrostatic speakers introduced in 1981. Their appearance is consistent with that era – whether that is a good or bad thing depends heavily on taste. The subwoofer has a more modern, polished metal appearance with a LED display at the front.

The amplifier/preamplifier/FM tuner group is made of three distinct units stacked in a small wooden cabinet, which is painted dark grey to match them. Individually they are the Quad FM4 tuner, Quad 44 preamplifier and Quad 405-2 100W Stereo Current

Fig.1: the frequency response of the Quad 405-2 amplifier. The -3dB points are 15Hz and 35kHz, which is within its specifications but not as flat as many modern amplifiers.

Fig.2: THD+N vs Power for the Quad 405-2 amplifier at 1kHz/8Ω, measured with a 20Hz-22kHz bandwidth. Its distortion at low powers is relatively high due to noise.

Dumping Amplifier. Interestingly, the amplifier pre-dates the ESL63 speakers – it was released in 1975 and was regarded as a landmark unit at the time.

Their front panels feature nicely machined metal switches, pushbuttons and knobs. Because all mains power passes through it, turning on the preamplifier also turns on the other components. It has five stereo inputs, a volume knob with 22 detents, a bass lift filter, a "tilt" filter (which cuts treble while it boosts bass and vice versa) and an adjustable low-pass filter. There is also a balance control and a stereo/mono switch.

The FM tuner is rather simple, with seven station preset buttons and a manual "tune" button. Tuning is accomplished with a knob and the nearest frequency (to within 50kHz) is shown on a digital display.

The power amplifier has no front panel as such, instead sporting a substantial black, finned heatsink across the full width.

The Quad CD player is similarly spartan, with just a power switch, eject button and display. The other controls are on the remote. Similarly, the subwoofer controls are handled entirely by the infrared remote.

Electrostatic speakers

Before we begin discussing the performance, it is worth explaining how these speakers work.

Modern "dynamic" loudspeakers use a voice coil/cone assembly and a rear-mounted permanent magnet. If an audio signal is fed to the voice coil, it interacts with the magnetic field produced by the magnet and the cone moves back and forth as a result to generate the sound waves.

By contrast, electrostatic loudspeakers use an electric field rather than a magnetic field. Each driver consists of a metallised plastic panel suspended between perforated sheet metal grids at the front and rear. This conductive sheet is charged up to a high voltage (in this case, 5.25kV).

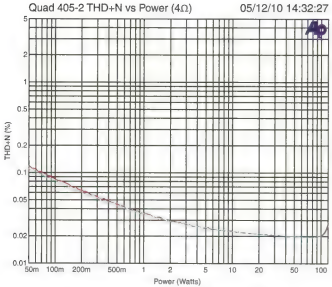


Fig.3: THD+N vs Power for the Quad 405-2 amplifier at 1kHz but with a 4Ω load. More power is available but noise and harmonic distortion levels are higher.

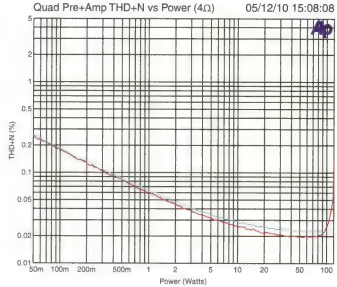


Fig.4: the same measurement as Fig.3 but with the Quad 44 preamplifier in circuit. It adds a lot of noise, increases the distortion level and reduces channel tracking, since there is no way to disable the balance control.

It is generated from the mains voltage so each electrostatic speaker needs a mains power connection (via an IEC socket on the base stand).

The audio signal from the amplifier is stepped up by a transformer which drives both grids. As a result, the very thin metallised sheet is moved by the electric field in a push-pull manner, generating the sound waves.

To get good performance across the audio spectrum, it is necessary to break the panel up into multiple zones of different shapes and sizes which are electrically independent (aside from the common high-voltage bias). Smaller sections reproduce treble and larger sections bass. A crossover filter network distributes the audio signal appropriately. Each ESL63 has eight of these zones.

One typical problem with electrostatic speakers is that, due to the transformer-coupled input, the DC resistance across the input terminals can be quite low which means that a special amplifier is required. However, the ESL63's input has just under 4Ω DC resistance so a standard 100W amplifier can be used (provided it is stable with transformer loads).

Subjective impressions

Before we hooked the gear up to our test equipment we thought we would have a listen. Since all the gear had been sent to the Quad factory in the UK for a check-up before being despatched to Australia we expected that it would all be performing up to scratch.

So how did it sound? Hmm, to be

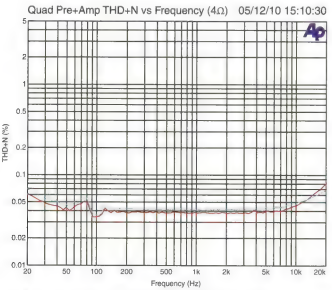


Fig.5: this graph shows THD+N vs frequency for the amplifier and preamplifier combination at 5W output into 4Ω. The distortion is above 0.04% across much of the frequency range.

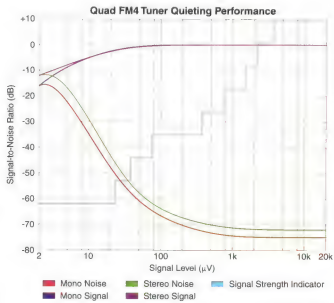


Fig.6: this graph shows how the tuner's signal-to-noise ratio is affected by RF signal strength. The ultimate signal-to-noise ratio is -75dB for mono and -72dB for stereo.

honest we were not overly excited. It was OK.

In more detail, our impression was that the treble was distinctly muted and certainly lacked the "sheen" of a system with a top-end ribbon or dome tweeter with ferrofluid cooling. Nor was the bass particularly notable, with the lowest octave from a piano, pipe organ, double-bass or harp just not there. The midrange was good; very smooth and without any tendency to emphasise voice or brass instruments. On the other hand, sibilants were muted, as were cymbals, snare drums and so on. The sound lacked zing.

To paraphrase that old Duke Ellington classic, "It don't mean a thing, if it ain't got that zing".

Furthermore, stereo imaging is diffuse due to the large radiating surfaces. You cannot pinpoint voices or instruments across a "stereo stage" as you can with a stereo system with conventional tweeters which are effectively point sources.

Initially, we listened to the system without the subwoofer but noting that low bass was missing, we connected it up and listened again. It gave a big improvement to the bass response, although the subwoofer needs careful adjustment to avoid giving exaggerated bass. In fact, we have always felt this way about subwoofers, unless they are very carefully set up so that the upper bass and low bass levels are correct.

Measurements

Overall, we were disappointed with our first listening session. So what was letting the side down? Was it the much-vaunted ESL-63 electrostatics, the famous Quad 405 "current dumping" amplifier, the Quad 44 preamplifier or the Quad CD player? Or all of the above?

It is difficult to measure the performance of the speakers themselves since we don't have a set-up with calibrated microphone and software but we made extensive measurements of the amplifier, preamplifier, tuner and CD player with our Audio Precision distortion analyser.

This revealed that, compared with the best hifi equipment available today, the Quad gear is fairly average. Sorry Mr Quad but this is the truth.

Let's look at the Quad 405 first. It has a reasonably flat frequency response which is -1dB at 20Hz and 20kHz (see Fig.1). Furthermore, its THD+N

Unlike the Japanese gear of the era, Quad hifi equipment was disarmingly simple in appearance. This photo shows Quad's 66 CD player (top), FM4 tuner, 44 stereo preamplifier and 405-2 stereo power amplifier (bottom).

(total harmonic distortion + noise) is around 0.01% for 8Ω loads and 0.02% for 4Ω loads (see Figs.2 & 3). Again, this is good but hardly world-beating. The relative flatness of the distortion curve indicates that the distortion is mostly harmonic, rather than the result of noise.

It also has a below average damping factor of 45 at 4Ω and 88 at 8Ω, although that isn't low enough to cause any serious degradation of the frequency response.

So why are we so cool on the Quad 405? Take a look at Table 1. It compares THD+N measurements of the Quad 405-2 to a progression of SILICON CHIP designs. As you can see, our Ultra-LD designs from the last 10 years or so are at least an order of magnitude better (ie, more than 10 times better). That's a big difference. Oh, and that's without considering our 20W Class-A design which is in a class of its own.

When the Quad 44 preamplifier performance is coupled to the amplifier it adds significant distortion, as can be seen in Fig.4. In fact, there is so much noise from the preamp that the THD+N measurement at 50mW is doubled. It also adds a moderate amount of additional harmonic distortion, bringing the minimum level up to 0.015% for 8Ω loads.

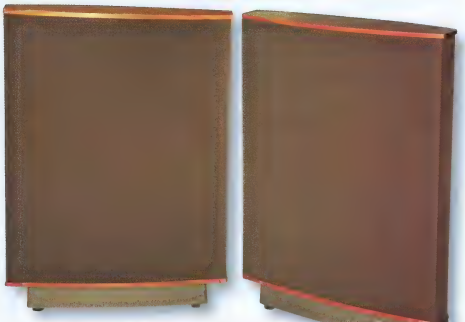
So even though the Quad 405 "current dumping" amplifier was a very significant design when it was first introduced in the late 1970s, it has been well and truly left behind.

FM tuner

By contrast, the Quad FM tuner performs well by modern standards. Its frequency response is ±1dB from 20Hz to 15kHz in both mono and stereo. THD+N is 0.09% for mono signals and 0.15% for stereo at 1kHz. Fig.6 shows the quieting curves along with the signal strength indicator bar reading (which is a 10 dot dual bargraph). Ultimate signal-to-noise ratio is above 70dB for mono and stereo

Table 1: Power Amplifier Performance Comparison

Amplifier	THD+N @ 1kHz 8Ω	THD+N @ 20kHz 8Ω
Quad 405-2	0.01%	0.02%
Studio 200 (February 1988)	<0.01%	Not stated
Plastic Power (April 1996)	0.0025%	0.01%
Ultra-LD (May 2000)	0.0015%	0.004%
SC-480 (January 2003)	0.003%	0.02%
Ultra-LD Mk.2 (August 2008)	0.0008%	0.0045%



Quad's ESL63 electrostatic loudspeakers. Each driver consists of a metallised plastic panel suspended between perforated sheet metal grids at the front and rear. The plastic panel is charged to 5.25kV and the audio signal is stepped up by a transformer and applied to the grids.

signals which is quite good.

Interestingly, while the FM tuner does have a digital frequency readout, it is not a synthesised design and it is tuned in the old-fashioned way by a tuning gang and knob, rather than in precise 50kHz steps denominated by a microprocessor. It is also quite difficult to tune precisely on station, necessary to get the best performance. That is one reason why frequency-synthesised designs took over.

CD player

The Quad 66 CD player is a reasonable performer by modern standards, although it has a surprisingly sharp rise in distortion above 12kHz. Compared to a 15-year old run-of-the-mill Sony CDP-XE300, the Quad 66 has lower distortion between 5kHz and 12kHz but somewhat higher distortion outside this range (see Table 3). It has a digital output so it could be connected to an external DAC (such as the SILICON CHIP DAC, September-November 2009) for lower distortion.

Its signal-to-noise ratio is good at -107dB and channel separation is excellent at -106dB at 10kHz. Overall linearity is also very good, with its output at -91.9dB for a -90dB signal. Frequency response is flat at -0.01dB and +0.05dB over 20Hz-20kHz; also pretty good.

Table 2: Quad FM4 Tuner Performance

Measurement	Mono	Stereo
THD+N	0.09%	0.15%
Signal-To-Noise Ratio	75dB	72dB
Minimum Signal Level for 3% THD+N	7μV (28dBf)	15μV (35dBf)
50dB Quieting	22μV (38dBf)	25μV (39dBf)

Table 3: Quad 66 CD Player vs Sony CDP-XE300

Measurement	Quad 66 CD Player	Sony CDP-XE300
THD+N, 1kHz (20Hz-22kHz)	0.00487%	0.00281%
THD+N, 10kHz (20Hz-80kHz)	0.00564%	0.01838%
THD+N, 15kHz (20Hz-80kHz)	0.02720%	0.02222%
THD+N, 20kHz (20Hz-80kHz)	0.18525%	0.01767%

Test reactions

Our overall reaction to the above tests was that clearly, while the individual Quad components were decent performers at the time they were released, they have been well and truly left behind as technology has progressed.

The electrostatic speakers have a certain charm with a smooth midrange but they struggle at the extremes of the audible range. Neither the Quad 405-2 amplifier nor Quad 44 preamplifier have particularly low distortion or noise. A modern, good quality amplifier/preamplifier combination will outperform them.

The FM tuner is fine but superior units are available from companies like Yamaha and Denon. The Quad CD player is merely average compared to most brand-name players released in the last 15 years and also the better quality DVD or BluRay players.

Finally, we decided to listen to the Quad ESL-63s when driven by an Ultra-LD Stereo Amplifier (SILICON CHIP, November 2001-January 2002) and the abovementioned Sony CD player, together with the Quad subwoofer. Talk about chalk and cheese! This combination gave extended treble and much more extended bass and was much more satisfying overall, on a wide variety of music. In fact, while you might want to keep the ESL-63s, you would not now bother with the rest of the original system.

No, that's not right – you would not bother with the electrostatics either. You would opt for a decent pair of dynamic loudspeakers – even Quad make those now!

Conclusion

All this is not to say that the (previously) revered Quad system sounds bad. It's still quite pleasant to listen to. We somehow needed to convey this reaction to our Serviceman. Remember that he paid a motsa to have the whole system checked over by Quad in the UK and then had it shipped out to Australia. Should we sugar-coat our reactions?

In the end, we gave it to him straight, "Mate, it's pretty ordinary".

He took it reasonably well, considering. SC

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Words by Leo Simpson
Design by Branko Justic*
*Oatley Electronics

High-power reversible DC motor speed controller

Here's a 12-32V 30A speed controller that's easy to build. It's available in two versions – reversible and non-reversible – and features soft start, relay switching of motor direction and PWM speed control.

THIS REVERSIBLE DC Motor Speed Controller uses a pair of high-power Mosfets connected in parallel to drive the motor and a unique relay changeover circuit to make it reversible. It can operate from 12-32V batteries at currents up to 30A. Logic control of the relay changeover circuit means that it can only change direction when the motor is stopped.

The unit comes in two kit versions. The first is the basic speed control with two paralleled Mosfets and a dual op amp to provide pulse width modulation (PWM). The second version adds the relay changeover circuit and its logic control. If you don't need a reversing feature, you only need buy the basic kit.

Either way, the speed control can be via an onboard trimpot, via an external 5kΩ potentiometer, or via a motorcycle throttle based on a Hall Effect sensor. This could be ideal for a wheelchair controller or an electric bike.

Circuit description

Refer now to Fig.3 which shows both sections of the circuit. The left-hand side is the basic speed controller while on the righthand side are the relays and associated logic control.

First, let's focus on IC1 (the LM358 dual op amp) and the 5kΩ potentiometer. Op amp IC1a and its associated components comprise a triangle wave oscillator. Its frequency is around 300Hz and its output amplitude is around 1V peak-to-peak. The mean DC level of this triangle waveform can be lifted up or down, dependent on the setting of the 5kΩ speed control potentiometer.

This output waveform is connected to the non-inverting input of IC1b, pin 5. IC1b is connected as a comparator and it compares the triangle waveform with the 3.5V fixed reference at its pin

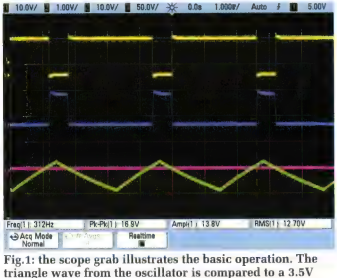

Fig.1: the scope grab illustrates the basic operation. The triangle wave from the oscillator is compared to a 3.5V reference (pink trace) and when it exceeds this reference, a corresponding motor drive pulse (blue trace) is produced.

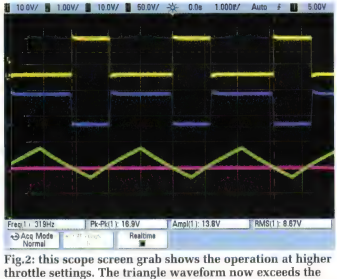

Fig.2: this scope screen grab shows the operation at higher throttle settings. The triangle waveform now exceeds the reference voltage for a greater proportion of the time and so the pulses fed to the motor are much wider.

6. When the speed control is advanced so that peaks of the triangular waveform at pin 5 exceed the 3.5V reference voltage at pin 6, the output at pin 7 goes high and this turns on two power Mosfets, Q6 & Q7.

This means that the Mosfets are pulsed on whenever the triangle waveform peaks go above 3.5V. Advancing the speed control increases the duty cycle of the pulses.

The circuit operation is demonstrated above in the two scope screen grabs of Fig.1 & Fig.2. In each case, the green trace shows the triangle waveform while the pink trace shows the 3.5V reference which is fixed. As you can see, each time a portion of the triangle waveform intersects the pink trace and is above it, there is a corresponding pulse to the Mosfet gates, as shown by the blue trace.

The voltage across the motor, between the positive supply line and the Mosfet drains, is shown in the yellow trace.

Fig.1 shows the operation at a very low throttle setting and so the pulses fed to the motor are very narrow and its speed will be low. By contrast, Fig.2 shows the operation at higher throttle settings. As can be seen, the corresponding pulses fed to the motor are much wider.

When the throttle control is fully advanced, this results in the triangle waveform being wholly above 3.5V. This means that pin 7 of IC1 remains high permanently and so Mosfets Q6 & Q7 are turned on continuously.

Soft start

When power is first applied to the controller circuit, the 100µF capacitor on pin 6 of IC1b is discharged which means that pin 6 will be high at about +7V. The capacitor then begins to charge via the 39kΩ resistors on pin 6, thus pulling the voltage at pin 6 down to 3.5V. Therefore, at the instant when the power is applied the motor cannot run, even if the throttle is fully advanced.

This gives the circuit a "soft start" feature and the motor cannot start with a lurch at initial power-up.

Two regulators

There are two transistor regulator

Where To Buy Kits

Kits for this project are available from Oatley Electronics Pty Ltd, PO Box 89, Oatley, NSW 2223. Phone (02) 9584 3563. Website: **oatleyelectronics.com**

The reversible version (Cat. K275) costs $39 plus p&p, while the basic non-reversible version is $24 plus p&p.

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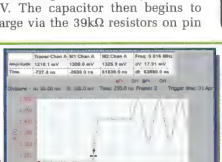

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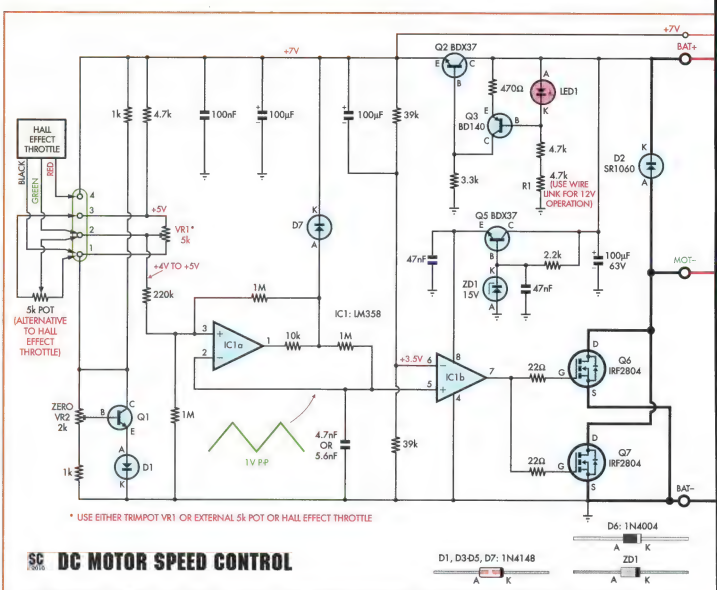


DC MOTOR SPEED CONTROL

Fig.3: the circuit uses op amp IC1a to generate a 300Hz triangle wave. This is DC level shifted using the throttle and fed to comparator IC1b which then generates the PWM square-wave pulses to drive Mosfets Q6 & Q7 and the motor. Relays RLY1, RLY1a, RLY2 & RLY2a and their associated control circuit (IC2a-IC2d) provide the reversing feature.

circuits in the controller. The first regulator, comprising transistors Q2 & Q3 and red LED1, provides the +7V rail. It works like this: LED1 provides a 1.8V reference at the base of Q3 and the resulting 1.1V at Q3's emitter causes 2.34mA to flow in its 470Ω emitter resistor and through the 3.3kΩ resistor at its collector. This provides +7.7V at Q4's base and so +7V appears at Q4's emitter. This sets the voltage conditions for the throttle and the triangle wave generator based on IC1a.

The second regulator is based on zener diode ZD1 and transistor Q5. ZD1 provides a 15V reference and is bypassed by a 47nF capacitor to the base of Q5 which operates as an emitter follower. Interestingly, for battery voltages of less than about 16V, ZD1 will not be biased on (ie, no zener current will flow) and therefore Q5 will act as a simple capacitance multiplier filter. It provides the supply rail to IC1 and thereby ensures that the gates of the Mosfets are driven with more than 10V, provided the battery voltage is at least 12V. This is desirable to ensure that the Mosfets are turned on fully to minimise their voltage loss and power dissipation.

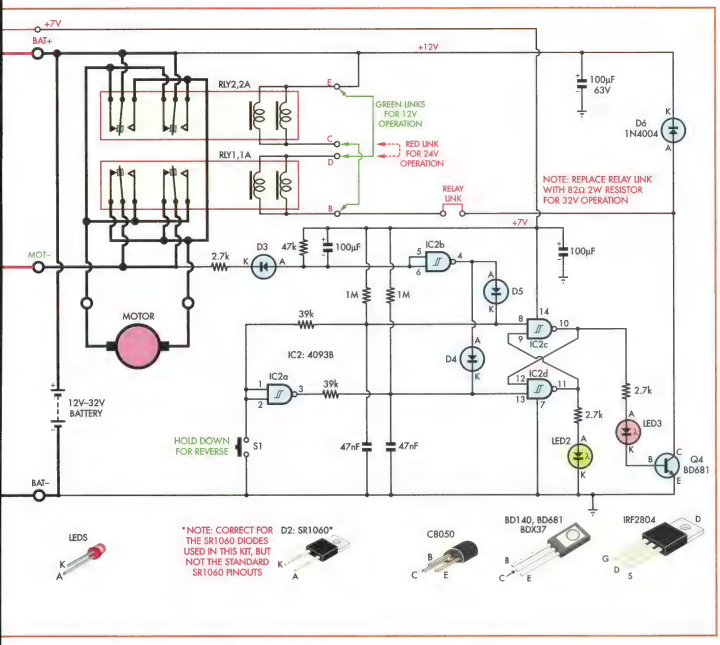
For higher battery voltages, up to 32V, ZD1 and Q5 ensure that the gate voltage delivered by IC1b is limited to about 13V.

Note that the circuit shows three alternative throttle arrangements. The first is via trimpot VR1 which can be installed on the PC board. The second is for an external 5kΩ speed control and the third is a twist grip Hall Effect throttle. Only one of these options can be used at any one time.

Trimpot VR2 is a zero control. This is adjusted so that no voltage is applied to the motor at the minimum setting of the speed control.

Relay switching

Having a speed control on a motor is all very well but in many applications you need to run the motor in forward or reverse. In order to do this on a DC motor, you need to swap the connections to the motor. In small motor circuits that could be done by a double-pole changeover switch but



when heavy currents are involved, relays are required.

In the simplest arrangement, this can be done with a single large double-pole double-throw (DPDT) relay or it could be done with two single-pole double-throw (SPDT) relays being switched simultaneously. This circuit is a little novel in that uses four SPDT relays with the relays used as paralleled pairs to substantially increase the switch contact rating.

But there is a further refinement in that the heavy motor currents are never actually broken by the relay contacts. Instead, the relays are only operated when the voltage across the load is zero and therefore no current is flowing. This means that there will not be any contact arcing and accompanying contact erosion.

Relay logic controller

The relay logic controller is based on a 4093 quad 2-input Schmitt trigger NAND gate package. Gates IC2c & IC2d are connected as an RS flipflop which can be set or reset by having one of its inputs at pins 8 & 13 pulled low. Pin 10 controls the relay switching transistor Q4, so when this output is high, the relays are on and this provides the reverse direction for the motor.

Pins 1 & 2 of IC2a are normally pulled high by the series-connected 1MΩ and 39kΩ resistors but when pushbutton switch S1 is pressed, the inputs are pulled low. When the motor is running, the drains of the Mosfets (Q6 & Q7) are being pulsed low and this repeatedly pulls the negative side of the 100µF capacitor connected to pins 5 & 6 of IC2b low, via diode D3. Hence the output of IC2b is high and this pulls pins 8 & 13 high via diodes D5 & D4 respectively, so the RS flipflop cannot be toggled. Therefore motor direction cannot be changed while ever it is running.

When the Mosfets are off, the motor stops running and pins 5 & 6 of IC2b are pulled high via the associated 47kΩ resistor, the 100µF capacitor being discharged. The motor direction cannot be changed during this discharge time which is around four seconds. This feature prevents sudden changes in the

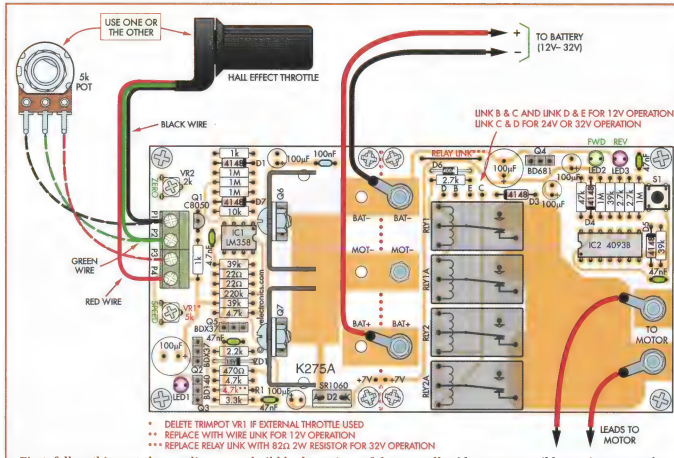


Fig.4: follow this parts layout diagram to build both versions of the controller (the non-reversible version uses only those parts to the left of the red dotted line). Note that some of the parts and linking options vary, depending on on whether the controller is to be powered from 12V, 24V or 32V.

motor direction and this 4s period of time can be lengthened or shortened by respectively increasing or decreasing the value of the 47kΩ resistor.

Now, when the motor voltage (and current) is zero, the RS flipflop can be toggled. So to change from forward to reverse direction, you press pushbutton switch S1. This not only pulls IC2a's inputs low but also pulls pin 8 of IC2c low and this sets the flipflop so that it turns on transistor Q4 and energises the two relay coils.

Note that as soon as you release pushbutton switch S1, it will immediately allow pins 1 & 2 of IC2a to go high again and this will cause pin 3 to go low. This will then reset the RS flipflop, thereby turning off transistor Q4 and lighting LED2, which indicates forward direction. **Hence, for reverse operation, you need to keep the pushbutton pressed.**

This makes sense if you are making this speed control for an electric bicycle and you only want reverse engaged for very limited time. **However, if the speed control needs to be in reverse mode for much longer periods, the pushbutton switch is not practical and you will need to substitute a standard SPST toggle switch.**

Building it

Both versions of the DC Motor Speed Control are available as kits from Oatley Electronics (see parts list). The reversible version is built on a double-sided PC board coded K275 (138 x 70mm), while the non-reversible version (without the relays) uses a double-sided PC board coded K275A (60 x 70mm).

Note that the parts layout on the latter is identical to the corresponding section on the fully-reversible version.

Fig.4 shows the assembly details. If you are building the non-reversible version, just follow the layout to the left of the red dotted line. Conversely, for the reversible version, you will need to assemble the entire board.

Begin by installing the resistors and diodes. Table 2 shows the resistor colour codes but check each resistor using a DMM before installing it. Note that resistor R1 (4.7kΩ, near LED1) should be replaced with a wire link for 12V operation.

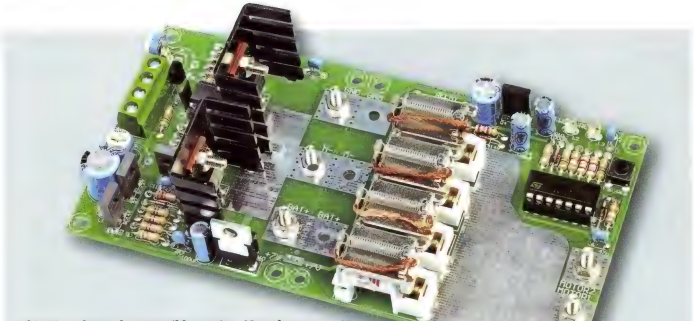
Conversely, you will need to install the resistor is you intend operating the controller from 24V or 32V.

Be sure to install the correct diode type at each location and check that they are all correctly orientated. Diode D2 (SR1060) goes in with its metal tab adjacent to the edge of the PC board.

Once these parts are in, install the

Table 1: Linking Options

Supply Rail	Relay Configuration	Relay Link	Resistor R1
12V	Link B & C, Link D & E	Wire Link	Wire Link
24V	Link C & D	Wire Link	4.7kΩ
32V	Link C & D	82Ω 2W Resistor	4.7kΩ



This view shows the reversible version. Note that you must fit M3 x 10mm screws to the BAT+, M-, GND and MOTOR positions to carry the high currents. It's also a good idea to run a layer of solder over the high-current copper lands for currents above 15A – see text.

capacitors and IC sockets. Check that the electrolytics are all correctly orientated and make sure that the sockets go in with their notched ends positioned as shown.

Now for the transistors. These should all be pushed down onto the PC board as far as they will comfortably go before soldering their leads. Use the correct type at each location and take care with their orientation – the metal faces of Q2 & Q3 face the 100µF capacitor and LED1 respectively, while Q5's metal side faces the adjacent 4.7kΩ resistor. Q4 goes in with its metal face towards the edge of the PC board.

The two power Mosfets (Q6 & Q7) should now be loosely attached to their U-shaped heatsinks using M3 x 10mm machine screws, washers and nuts. That done, install each assembly in position and push it down until the bottom edge of its heatsink rests against the PC board. The heatsink tabs should go through the holes in the board and these should be bent using pliers to hold the assemblies in position while you solder the device leads.

Bending the heatsink tabs will also make the assemblies more secure, particularly if the board will later be subject to vibration. Once everything is in place, tighten the screws that secure the Mosfet tabs to the heatsinks.

Trimpot VR2 (2kΩ) can be installed and the board has been designed to accept either a horizontal or vertical trimpot. **The same goes for trimpot VR1 (5kΩ) but you must leave this part out if you are using an external throttle to control motor speed.** VR1 is installed only if you are using the controller to set a fixed motor speed (ie, no external throttle).

The two ICs can now be plugged into their sockets (note: they face in opposite directions) and the relays installed. These relays will only fit

Table 3: Capacitor Codes

Value	µF Value	IEC Code	EIA Code
100nF	0.1µF	100n	104
47nF	.047µF	47n	473
4.7nF	.0047µF	4n7	472

Table 2: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	3	1MΩ	brown black green brown	brown black black yellow brown
❑	1	220kΩ	red red yellow brown	red red black orange brown
❑	1	47kΩ	yellow violet orange brown	yellow violet black red brown
❑	4	39kΩ	orange white orange brown	orange white black red brown
❑	1	10kΩ	brown black orange brown	brown black black red brown
❑	3	4.7kΩ	yellow violet red brown	yellow violet black brown brown
❑	1	3.3kΩ	orange orange red brown	orange orange black brown brown
❑	3	2.7kΩ	red violet red brown	red violet black brown brown
❑	1	2.2kΩ	red red red brown	red red black brown brown
❑	2	1kΩ	brown black red brown	brown black black brown brown
❑	1	470Ω	yellow violet brown brown	yellow violet black black brown
❑	2	22Ω	red red black brown	red red black gold brown

The basic non-reversible version is shown here, together with the optional handle-bar type (Hall effect) throttle. Be sure to omit trimpot VR1 from the board if you intend using an external throttle – see text.

Parts List: Kit K275A

1 PC board, code K275A, 60 x 70mm
2 PC-mount 2-way screw terminal blocks
1 5kΩ trimpot (VR1)
1 2kΩ trimpot (VR2)
1 8-pin DIP IC socket
5 M3 x 10mm machine screws
5 M3 nuts
5 M3 washers
2 heatsinks
Tinned copper wire for links

Semiconductors

1 LM358 dual op amp (IC1)
1 C8050 NPN transistor (Q1)
2 BDX37 NPN transistor (Q2,Q5)
1 BD140 NPN transistor (Q3)
2 IRF2804 Mosfets (Q6,Q7)
1 15V zener diode (ZD1)
2 1N4148 small-signal diodes (D1,D7)
1 SR1060 Schottky diode (D2)
1 red 3mm LED (LED1)

Capacitors

1 100µF 63V electrolytic
2 100µF 16V electrolytic
1 100nF monolithic
2 47nF monolithic
1 4.7nF greencap

Resistors (0.25W, 5%)

3 1MΩ	1 3.3kΩ
1 220kΩ	1 2.2kΩ
2 39kΩ	2 1kΩ
1 10kΩ	1 470Ω
3 4.7kΩ	2 22Ω

one way and you should use generous amounts of solder on their contact pins since they can carry quite high currents.

Forward/reverse switch

Pushbutton switch S1 is the Forward/Reverse switch. This should only be installed on the board if you want a switch that you hold down for reverse operation (ie, if you only want reverse for a short time).

However, as stated above, you will need to substitute a standard SPST toggle switch if you want reverse for extended periods of time. In that case, just connect the switch contacts to the appropriate pads on the PC board using flying leads.

Linking options

There are several linking options and component changes, depending on whether you are operating the controller from 12V, 24V or 32V. Table 1 shows the details.

First, on the reversible version, you will need install the "Relay Link" at the top of the board (above the relays). This is simply a wire link for operation up to 24V but this must be replaced with an 82Ω 2W resistor (not supplied with the kit) for 32V operation.

Similarly, you also need to link the relay coils for either parallel or series operation, depending on the supply voltage. For 12V operation, use separate wire links to connect points B & C together and points D & E together. Alternatively, for 24V or 32V operation, connect points C & D together (don't forget to replace the Relay Link with an 82Ω 2W resistor for 32V operation – see above).

Note that the two links installed for 12V operation overlap each other. Be sure to position them so that they cannot short together (or sleeve them with heatshrink, or use insulated wire).

The final option concerns one of the 4.7kΩ resistors (R1) in series with LED1. As stated previously, this must be replaced with a wire link for 12V operation.

High-current connections

All connections to the motor and battery must be run via crimped eyelet connectors which are attached to the PC board using M3 x 10mm machine screws, washers and nuts. In addition, if building the reversible version, **you must also fit an M3 x 10mm screw, washer and nut to the MOT- hole position, immediately to the left of relay RLY1A (see Fig.4).**

That last step is important because the screw through the MOT- hole helps carry the heavy currents that flow through the motor and power

Mosfets Q6 & Q7. The same goes for the machine screws that are used to terminate the eyelets for the battery and motor connections.

In short, you must have machine screws running through the BAT+, BAT-, MOT- and TO MOTOR holes to carry the heavy currents involved. Don't just rely on the through-hole plating of the board – it could "fuse" under high-current conditions.

If you are building the smaller non-reversible version, use the alternative BAT-, MOT- & BAT+ connections shown on Fig.4. The motor is connected between MOT- and BAT+. As before, all connections must be made via crimped eyelet connectors which are attached using M3 x 10mm screws, washers and nuts.

Make sure that the leads are adequately rated to carry the currents involved. Generally, this will involve using heavy-duty cabling rated at 15A or greater if required.

Finally, for currents above about 15A, run a thick layer of solder over all the high-current copper lands on the PC board. This must be done on both sides of the board and involves the lands running to the power Mosfets, the motor and battery connections and the relay contacts.

Testing

When the assembly is complete, check your work very carefully. Any mistakes in component placement or polarity could result in damage when the power supply is connected. **Supply polarity is also crucial – getting it wrong can seriously damage the unit.**

Parts List: Kit K275 (Reversible Version)

1 PC board, code K275, 138 x 70mm
1 PC-mount tactile switch (S1)
2 PC-mount 2-way screw terminal blocks
1 5kΩ trimpot (VR1)
1 2kΩ trimpot (VR2)
1 8-pin DIP IC socket
1 14-pin DIP IC socket
4 12V 30A relays
7 M3 x 10mm machine screws
7 M3 nuts
7 M3 washers
2 heatsinks
Tinned copper wire for links

Semiconductors
1 LM358 dual op amp (IC1)
1 4093 quad 2-input NAND gate (IC2)
2 red 3mm LEDs (LED1, LED3)
1 green 3mm LED (LED2)
1 C8050 NPN transistor (Q1)
2 BDX37 NPN transistor (Q2,Q5)
1 BD140 NPN transistor (Q3)
1 BD681 NPN Darlington transistor (Q4)
2 IRF2804 Mosfets (Q6,Q7)
1 15V zener diode (ZD1)
5 1N4148 small signal diodes (D1,D3-D5,D7)
1 SR1060 Schottky diode (D2)
1 1N4004 1A diode (D6)

Capacitors
2 100µF 63V electrolytic
4 100µF 16V electrolytic
1 100nF monolithic
4 47nF monolithic
1 4.7nF greencap

Resistors (0.25W, 5%)

5 1MΩ	1 3.3kΩ
1 220kΩ	3 2.7kΩ
1 47kΩ	1 2.2kΩ
4 39kΩ	2 1kΩ
1 10kΩ	1 470Ω
3 4.7kΩ	2 22Ω

If everything checks OK, connect a 12V battery (or other high-current DC power supply) but do not connect the motor yet. Now check that +7V is present on the emitter of transistor Q1. If it is, set the throttle (either an external pot or VR1) to minimum and monitor the voltage at pin 7 of IC1. This voltage should vary as you vary the throttle and if you have an oscilloscope, you can check that the PWM duty cycle varies as shown on the scope screen shots of Fig.1 & Fig.2.

Next, set the throttle to minimum, connect a motor and connect your DMM (set to volts) across the motor's terminals. Adjust trimpot VR2 for a reading of 0V – this will zero the controller's output when the throttle is at minimum. Alternatively, you can set it to give a minimum motor speed.

Now try adjusting the throttle. The motor should start and respond to throttle adjustments and the DMM should indicate corresponding voltage variations. SC

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By NICHOLAS VINEN

Remote-Controlled Digital Up/Down Timer

This remote-controlled digital timer has a bright 20mm-high 7-segment red LED display & can count up or down from one second to 100 hours in 1-second steps. Its timing period can either be set and controlled using the remote control or it can be automatically controlled via external trigger/reset inputs. An internal relay and buzzer activate when the unit times out.

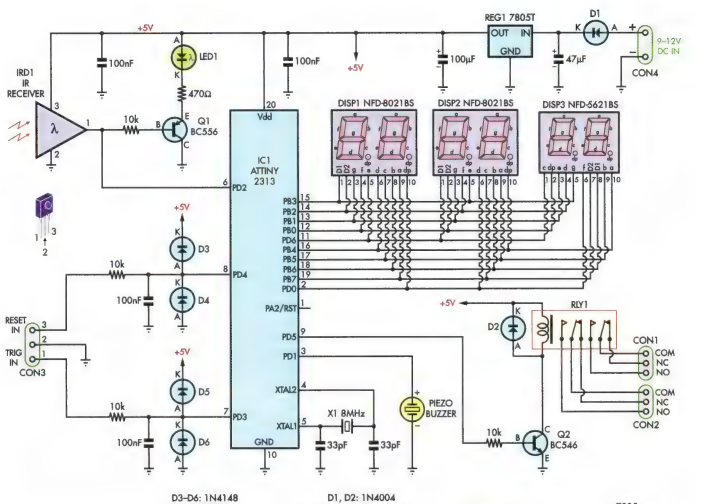
THIS NEW DIGITAL TIMER is a very flexible project. We can think of many uses for it but we are sure there are a lot more that we haven't even considered.

We've done lots of timers before but this one has the convenience of remote control. Its timing period can be programmed using the numerical keypad button on the remote, while the remote's Power/Standby button provides a Reset function.

The simplest way to use it is like a kitchen timer. In this mode, it can count up or down for the timing period, as entered via the keypad on the remote. Pressing the remote's Channel Up button make the unit count up to the programmed time, while pressing the Channel Down button makes it count down.

When the time runs out, the LED display flashes and a buzzer sounds for a preset period (the default is one minute) or until the reset button is pressed. You can either use the Power/Standby button on the remote to reset the unit or an external reset button.

The internal relay also switches at the end of the timing interval. This relay can directly control a DC device (30V DC or 24V AC max.) or it can indirectly control a mains-powered device via a separate external mains-rated relay (see panel). **Note, however, that this unit is definitely NOT RATED**



REMOTE-CONTROLLED DIGITAL TIMER

Fig.1: the circuit is based on an Atmel ATTiny2313 microcontroller (IC1), three dual 7-segment LED readouts and an infrared receiver (IRD1). The micro drives the LEDs, controls the timing and drives a DPDT relay via transistor Q2.

to directly switch mains devices.

By default, the relay is energised while the timer is running. As such, the timer could be used to run an oven for the programmed timing period, expose a PC board to UV light, or run a fan or light for a fixed period, etc.

The trigger and reset inputs can be used to automatically start and stop the timer when certain events occur, eg, when a door opens, an external button is pressed or a PIR (passive infrared) sensor is triggered by motion, etc. This means that you could set it up to turn on a light or fan when a door is opened and then subsequently switch the device off when the door is shut or after the programmed period expires.

It could even be used as the basis of a very simple alarm system. All you have to do is connect a PIR sensor to the trigger input, a key-switch to the reset input and a siren to the relay. You then set the timer to a short period (say 30 seconds) and the alarm period to a value that's longer than the default (say three minutes) and voila! . . . you have a basic motion-triggered alarm with key deactivation.

By the way, the unit will work with virtually any universal remote control that's capable of transmitting Philips RC5 codes (nearly all do). So if you have a spare universal remote control, it will do the job quite nicely.

Circuit description

Take a look now at Fig.1 for the full circuit details. It's based on microcontroller IC1 plus three dual 7-segment LED readouts. However, instead of using a PIC micro as in most other projects, this time we've opted for an Atmel ATTiny2313 with 2048 bytes of flash memory.

The micro normally runs at 8MHz, as set by an internal 8MHz oscillator and crystal X1. This clock frequency is reduced to 1MHz (via a clock divider) when the micro is in standby mode.

Note that although the micro actually has an internal 8MHz oscillator, the crystal is necessary for accurate timekeeping. Typical crystal error is less than 100ppm or 0.01%, giving a maximum timing error is one second per three hours although it will normally be well under half that.

The unusual part of this circuit is the way in which the six 7-segment

Parts List

1 PC board, code 19108101, 89 x 80mm
1 sealed polycarbonate enclosure, 115 x 90 x 55mm with clear lid (Jaycar HB-6246)
1 universal remote control with numeric keypad (eg, Jaycar AR-1726, Altronics A-1012)
1 9-12V DC 300mA plugpack (Jaycar MP-3147, Altronics M-8928 or similar)
1 6-way chassis-mount terminal barrier (Jaycar HM-3168, Altronics P-2076A)
1 5V DPDT DIL relay (Futurlec HFD2-05, Altronics S-4147 or equivalent) (RLY1)
1 PC-mount 5V mini piezoelectric buzzer (Jaycar AB-3459, Altronics S-6105)
1 8MHz HC-49 crystal resonator (X1)
1 20-pin DIL IC socket
3 mini 3-way terminal blocks (5.08mm pitch) (CON1-CON3
1 2-way polarised header (2.54mm pitch) (CON4)
1 2-way polarised header connector (2.54mm pitch)
1 2.1mm ID panel-mount DC socket (Jaycar PS-0522, Altronics P-0622)
4 M3 x 15mm tapped Nylon spacers
6 M3 x 20mm pan head machine screws
2 M3 nuts
2 M3 flat washers
2 M3 spring washers
Medium-duty hook-up wire: 50mm lengths of black and red, 130mm lengths of brown, orange, yellow, green, blue and white

Semiconductors

1 ATTiny2313 microcontroller (IC1) programmed with 1910810A.hex
1 7805T 5V regulator (REG1)
1 infrared receiver (IRD1)
1 BC556 PNP transistor (Q1)
1 BC546 NPN transistor (Q2)
2 7RD/NFD-8021BS 20mm dual high-brightness common anode 7-segment LED displays (DISP1-2) (available from Futurlec)
1 7RD/NFD-5621BS 14mm dual high-brightness common anode 7-segment LED display (DISP3) (available from Futurlec)
1 green 5mm LED (LED1)
2 1N4004 diodes (D1-D2)
4 1N4148 diodes (D3-D6)

Capacitors

1 100µF 16V electrolytic
1 47µF 25V electrolytic
4 100nF MKT
2 33pF ceramic

Resistors

4 10kΩ 1 470Ω

LED digits (DISP1-3) are driven. Just 10 of IC1's 20 pins are used to drive the 48 segments (seven per digit plus the six decimal points). What's more, we have not used any discrete transistors or current limiting resistors in the LED drive circuit. This makes the project smaller, cheaper and easier to build but how do we get away with it?

First, we are using a "charlieplexing" system (popularised by Charlie Allen at Maxim) which cuts down on the number of pins required to drive the LEDs. This is a special form of multiplexing and to understand how it works, first consider display DISP1. This contains two of the digits and has 10 pins – two common anodes and eight shared cathodes.

If we wire up just this display, then turning on any single segment is easy. We start by pulling one of the common anodes pins high – pin 1 for the first digit or pin 2 for the second digit. We then drive one of the cathode pins low, so that one of the 16 LEDs in the display has a complete circuit, ie, is driven at both ends. This ensures that only that segment lights up.

The other eight lines remain high impedance ("Tri-stated") in order to avoid turning on any of the other segments.

To drive the second display, we reuse the same set of pins on the micro but we use two different ones for driving the anodes. For example, here we are using pins 15 & 14 of the micro to drive the anodes in DISP1, while pins 11 & 12 drive the anodes in DISP2.

With this arrangement, when any segment in display DISP1 is illuminated, there is also a voltage present across one of the segments within DISP2. However, because DISP2's anode pins are connected only to DISP1's cathodes, that LED is reverse biased and so it does not light. The same is true in reverse, ie, driving a segment in DISP2 will reverse bias a segment in DISP1.

The same applies for DISP3, which has its anodes driven from pins 18 & 19 of the micro. As a result, no two common anodes are joined to the same microcontroller output. Thus, by being clever as to which lines are driven high and low at any one time (as set by the micro's internal firmware) and leaving the rest at high impedance, we can light any one of the 48 segments.

Multiplexing

While this scheme theoretically allows us to light more than one segment at once (in fact we could light all the segments in a single digit quite easily), in practice we would need external anode driver transistors to do this. The microcontroller outputs simply can't provide enough current to light multiple segments simultaneously, at least not without affecting their brightness.

So each segment in the display is lit individually in sequence. Because this happens so rapidly, the persistence of vision effect in our eyes makes it appear as if all the segments are lit simultaneously. This is much the same technique that's generally used to multiplex a multi-digit 7-segment LED display, except that normally all the segments of each digit are lit simultaneously.

In this case, we have taken the multiplexing to its extreme and as a result, the individual segment duty cycle is less than 2%. In other words, each segment is lit for less than 1/50th of the total time.

We can get away with this for two reasons. First, the LED displays are very bright, so despite each segment being lit for such a short period, they are still quite visible. Second, we are driving them above their rated DC current (but below their rated pulse current), thereby increasing their instantaneous (and thus average) brightness.

This scheme has yet another advantage. Because the number of segments being lit at any one time never varies

(it's always one), the displays do not vary their brightness according to the value. Look carefully at a commercial device with a 7-segment LED display (eg, a microwave or clock/radio) and you will find that in many cases, the brightness varies quite dramatically between a digit reading "1" and one reading "8".

Current limiting

The microcontroller runs off a +5V rail (more on this later) and the LED segments have a typical forward voltage of around 2V. So how does the microcontroller drive the LEDs, or for that matter its internal output transistors, without burning them out?

The answer is that these output transistors, for both the anode and cathode drive, have a fairly significant internal resistance. This limits the current to a safe level but only if the segment duty cycle is kept low. As mentioned earlier, the duty cycle has to be less than 2% due to the number of segments and calculations show that this is safe for both the micro and the displays.

Let's take a closer look at these calculations. The ATTiny2313 datasheet does not specify any dissipation limits but we can estimate them from its current limits. In this case, the maximum current per I/O pin is given as 40mA, while the maximum current for the entire micro is 200mA.

By referring to the "I/O Pin Source Current vs. Output Voltage (V_{CC} = 5V)" and "I/O Pin Sink Current vs. Output Voltage (V_{CC} = 5V)" graphs, we can calculate the maximum average dissipation for the output transistors in the worst case temperature. This is 48mW for the pull-up transistors and 42mW for the pull-down transistors.

Since it is permissible to have up to five I/O pins sourcing 40mA and five I/O pins sinking 40mA simultaneously (40mA x 5 = 200mA) then we can calculate that the maximum package dissipation must be at least (48mW + 42mW) x 5 = 450mW.

Average dissipation

We can now calculate the actual dissipation in the output transistors to check that it is safe.

First, we assume that the voltage drop across each LED segment is around 2V. In reality, it will be higher than this due to the higher than normal current but using a 2V figure is the conservative approach. This means the current through the LED will be such that the sum of the voltage drops across the output transistors is 3V (ie, 5V - 2V).

By referring to the sink and source graphs previously mentioned, we can calculate that the worst case current flow is 65mA at -40°C. The instantaneous dissipation will thus be 118mW in the source transistor, 130mW in the LED and 76mW in the sink transistor.

Since the current source transistors have a duty cycle of no more than 1:6 (there are six digits) and the sink transistors have a duty cycle of no more than 1:8 (eight segments), we can calculate the maximum average dissipation figures. These turn out to be 19.7mW for the source transistors, 2.7mW for the LEDs and 9.5mW for the sink transistors. The total average dissipation in the microcontroller is just 194mW.

These figures are all well below the maximum continuous ratings. So as long as we are careful to turn on each segment for just a short period (to prevent heat build up), then no damage should occur. In fact, in this design, each segment is lit for 10-20µs at a time and thus the refresh rate is around 1kHz.

Measurements on the prototype confirm these calculations. With the microcontroller running at 8MHz and no segments lit, the current drain is around 12mA. Conversely, with all the segments lit, it is around 50mA. This suggests that the instantaneous current through each LED is in the range of 40-50mA, which is slightly less than we have calculated.

Infrared remote control

Control signals from the remote are picked up by infrared receiver IRD1 and fed to the PD2/INT0 input (pin 6) of IC1. IRD1 also drives LED1 (a green 5mm type) via PNP transistor Q1 and this LED flashes when ever an infrared transmission is received. However, it does not guarantee that there were no errors in the reception – if there are then IC1 will ignore the signal. LED1 simply flashes brightly when infrared (IR) data is received.

A typical infrared remote control produces a modulated signal at around 36-38kHz. The IR receiver (IRD1) includes an internal 30-40kHz bandpass filter in order to remove any signals that may be present from flickering lights or other infrared sources.

Unfortunately, while this filter does a good job of preventing unintentional signals from triggering its output, it is not perfect. As a result, some red light reflected back to the receiver from the LED displays can cause occasional false triggering and this can be made worse if there are lights shining directly on the unit, as their flickering can interact and produce beat frequencies.

Ultimately, this isn't a problem because the microcontroller recognises only legitimate 889µs-long control pulses and ignores the shorter pulses caused by interference. As a result, false triggering at the IR receiver's output is rejected by the micro's firmware and has no effect on the timer's operation.

Minor effects

The false triggering does have two minor effects, though. One is that the onboard green LED can briefly flicker under some situations, as it directly monitors IRD1's output. However, the LED lights much more brightly when

Specifications

Timing range: 1 second to 100 hours (360,000 seconds) in 1-second steps.

Timing direction: unit can count up or down.

Remote control: can be set and controlled using a universal remote control.

External inputs: can be triggered and reset using external inputs; timer counts up or down from a preset value when externally triggered.

Outputs: DPDT (double-pole double-throw) relay outputs – relay can be on or off while counting and then changes state for the duration of the alarm period.

Relay contact rating: 30V DC or 24V AC (must NOT be used to switch mains appliances).

Power supply: 9-12V DC 300mA plugpack or a battery.

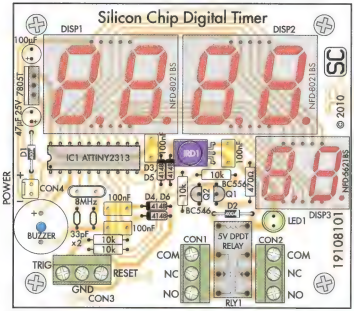


Fig.2: follow this parts layout diagram to build the PC board. Be careful not to get transistors Q1 & Q2 mixed up and note that the displays must be mounted with their decimal points towards the bottom.

This photo shows the fully-assembled prototype board. Note that there are a few minor differences between this board and the final version shown in the wiring diagram of Fig.2

the device is receiving genuine signals from the remote, so it's easy to distinguish between the two situations.

The second problem is that if there is a lot of light shining directly into the device, it can cause occasional reception errors when using the remote. Our tests have shown that the device can be reliably controlled from at least 5m away in most situations. It still works under adverse conditions but you may occasionally have to press a remote button more than once or correct a misinterpreted command when programming the unit.

Support circuitry

Pin 3 of IC1 drives the piezoelectric buzzer and this is activated for one minute at the end of the timing period. It is driven directly from output PD1 as it only consumes a few milliamps. It is also switched alternately on and off at 1Hz to save power and make its sound more obvious.

Note that its 1-minute period is the default value and this can be altered if necessary.

Relay RLY1 (a standard 5V micro DPDT type) is driven from output PD5 (pin 9) of IC1, in this case via NPN transistor Q2. Diode D2 protects the transistor by quenching the back-EMF voltage spikes that are produced when the relay is switched off. All six relay contacts are connected to terminal blocks CON1 & CON2 so they can be connected to the output terminals on the outside of the case as you see fit.

The trigger and reset inputs are provided via 3-way terminal block CON3 and a pair of RC filters (10kΩ and 100nF). These serve two purposes: (1) they filter out any noise or transients from the signals; and (2) in combination with diodes D3-D6, they protect IC1 from excessive voltage in either direction. As a result, it is safe to apply at least ±36V to either input.

These inputs are connected to ports PD3 and PD4 (pins 7 & 8) of IC1. Voltages below 1.5V are considered "low" while voltages above 3V are considered "high". The micro can be configured as to whether a low or high state activates the appropriate function (trigger or reset).

PD3 and PD4 also have a weak pull-up resistor enabled within the microcontroller. This allows you to attach a switch, pushbutton or relay between the inputs and ground for passive triggering. In this case, you would configure the input as active-low for use with a normally open switch or active-high for use with a normally closed switch.

Power supply

Power for the unit can either be derived from a 9-12V DC 300mA plugpack or from a suitable 9-12V battery. The positive rail is fed in via diode DI, which provides reverse polarity protection, and applied to 3-terminal regulator REG1 (7805). REG1 then provides a regulated +5V rail to power the circuit (including the relays), while the 47µF and 100µF capacitors on either side of REG provide the necessary supply line filtering.

The idle current is around 8.6mA and the maximum current drain is about 100mA with all LEDs lit, the relay on and the buzzer sounding.

Most of the idle current is consumed by the 7805 regulator (up to 6mA) and the infrared receiver (up to 4mA).

If you want to power it from a battery, especially one comprising alkaline cells, it would be a good idea to replace D1 with a 1N5819 Schottky diode and REG1 with an LM2940IT-5 low drop-out regulator. The LM2940 has a slightly higher quiescent current but will allow the timer to run down to a much lower battery voltage.

Board assembly

Most the parts are installed on a PC board coded 19108101 and measuring 89 x 80mm. Begin by carefully checking the copper side for defects (breaks or short circuits), then check that all the holes have been drilled to the correct size. You may have to test fit some of the parts (eg, the terminal blocks and displays) to confirm this.

Check also that the four corner mounting holes have been drilled to 3mm and that the board fits inside the plastic case. If it won't go in, you may need to file the corners slightly.

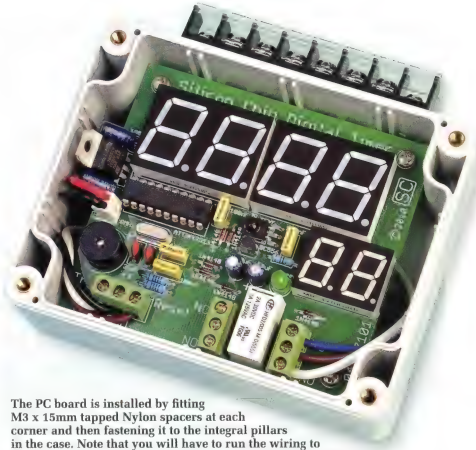
Fig.2 shows the parts layout on the PC board. Install the resistors first, followed by the four 1N4148 small signal diodes (D3-D6) which go in the middle of the board. The two larger 1N4004 diodes (D1 & D2) can then be installed. Make sure that all diodes are correctly orientated.

Next, install the IC socket with its notch closest to D1 – see Fig.2. Solder its two diagonally opposite pins first, then make sure it's sitting flat on the board before soldering the rest. The two ceramic and four MKT capacitors can then be installed.

Follow these with the two transistors (Q1 & Q2). Note that Q1 is a PNP BC556 type while Q2 is an NPN BC546, so be careful not to get them mixed up. If their leads are too close together to fit through the holes on the board, crank them out with small pliers, then back down again so that they slide easily into place.

Mounting the displays

It's now time to install the three dual



The PC board is installed by fitting M3 x 15mm tapped Nylon spacers at each corner and then fastening it to the integral pillars in the case. Note that you will have to run the wiring to the DC socket and the barrier terminal strip before this is done.

LED displays (leave the protective plastic on while you do this). For best appearance, they must sit perfectly flat against the PC board and should be parallel with the board edges. They also fit the board if installed upside-down, so be careful with their orientation – the decimal points must be towards the bottom.

Before mounting the displays, check that their pins haven't been bent during transport. If so, they can be carefully straightened with pliers. Be sure to push each display all the way down so that it sits flush against the board. It's best to solder two diagonally opposite pins first. That way, you can check that the display is correctly orientated and is flush with the board before soldering its remaining pins.

The two electrolytic capacitors are next on the list. Check their polarity carefully when installing them and be careful not to get them mixed up. They should both be mounted about 3mm proud of the board so that they can later be bent over at about a 45° angle – see photos. That way, they won't intrude on the display.

Once these parts are in, install the green LED (LED1). This goes in with its flat (cathode) side towards 7-segment LED display DISP3. Push it all the way down onto the board and check its orientation before soldering its leads.

Now for the infrared receiver (IRD1).

Table 2: Capacitor Codes

Value	µF Value	IEC Code	EIA Code
100nF	0.1µF	100n	104
33pF	NA	33p	33

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	4	10kΩ	brown black orange brown	brown black black red brown
❑	1	470Ω	yellow violet brown brown	yellow violet black black brown

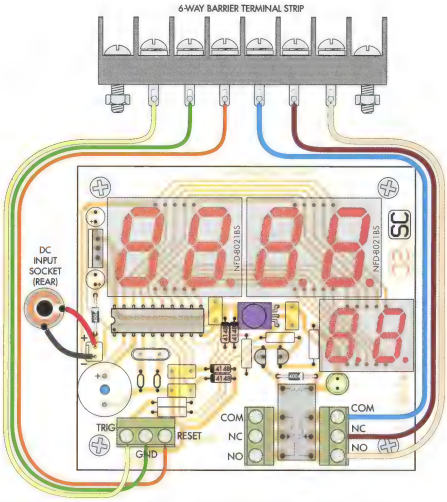


Fig.3: here's how to wire the DC input socket and connect the external Trigger & Reset inputs plus one pole of the relay to the 6-way barrier terminal strip. Alternatively, if you don't need the Trigger & Reset inputs, you can connect both relay poles or you can use a second terminal strip.

As shown in Fig.2, this is installed with its body flat against the PC board (domed lens facing upwards). This simply involves bending its leads down by 90° about 3mm away from its body before soldering it in position.

The three screw terminal blocks (CON1-CON3) can now be soldered in. Note that CON1 & CON2 must be orientated so that their entry holes face away from the relay. Similarly, CON3 should be installed with its entry holes towards the adjacent edge of the board. Check that they sit flush against the board before soldering their pins.

Follow these with the relay, which again should sit flat against the board. After that, fit the buzzer, which must be installed with its positive pin (indicated on the body) towards CON4. The 2-pin polarised header (CON4) can then go in – install it with its locking tab towards the adjacent edge of the board.

The 8MHz crystal and the 7805T regulator are next. The crystal can go in either way around while the 7805T must go in with its metal tab towards the adjacent edge of the board. Solder the regulator's leads, then bend it away from the displays at a 45° angle so that it doesn't later impinge on display visibility.

Microcontroller

You can now complete the board assembly by installing the microcontroller. If it came pre-programmed (as in a kit), all you need to do is make sure its pins are straight and then push it down into the socket with the correct orientation.

If you need to program it first, you must do it out-of-circuit as some of the programming pins are connected across LEDs. Install the hex file (available from the SILICON CHIP website) into its flash memory and don't forget to set the fuse bits, which are documented in the accompanying text file, otherwise it may not work correctly.

Final assembly

The PC board is designed to fit in a Jaycar HB-6246 polycarbonate case with clear lid. We have also produced a slightly modified board to suit the similar Altronics H-0324 box (both board patterns can be download from the SILICON CHIP website).

Basically, you can customise the connections on the box to suit your needs. For example, if you want to power the unit from a battery you may decide to install an on/off switch to avoid draining the battery when you are not using it. And if you don't need the trigger and reset connections (ie, you will be using the remote control only), then you won't need to run leads from CON3 to an external connector.

As shown in Fig.3, we used a 6-way chassis-mount terminal barrier to terminate the trigger/reset inputs and one relay pole. A 2.1mm chassis-mount DC socket mounted on one side of the case is used for the power input. This is connected to a polarised header plug via two short leads (red for positive, black for negative) which is then plugged into CON4.

The second relay pole was not connected in our prototype. If you do want to connect it, there is room on the other (bottom) side of the case for a second terminal barrier. We left the bottom clear so that the completed unit can rest on a flat surface but if we were mounting it on a wall, the bottom would be the logical location for the connections to be made.

Assuming you want to assemble your timer as shown in Fig.3, you will need to drill eight holes along the top edge of the box and one hole in the lefthand side for the DC connector. Fig.4 shows the drilling details. This can either be photocopied and the sections used as drilling templates or you can download the diagram from the SILICON CHIP website and print it out.

You can attach the templates using adhesive tape. Make sure they are correctly positioned before drilling the holes (the terminal barrier and DC socket must both sit low enough to clear the PC board when it is installed

in the case). Drill small pilot holes at each location first, then enlarge them by stepping up to the correct drill size. Finally, deburr each hole using an oversize drill.

The terminal barrier can now be pushed through and secured using two M3 x 20mm machine screws (one at either end). Use a flat washer under the head of each screw and a spring washer and nut inside the case. The DC socket can then be installed but you will have to discard its washer as the box is too thick for it. Do the nut up firmly so it can't rotate.

Wiring

It's now just a matter of completing the wiring as shown in Fig.3, using medium-duty hook-up wire. Cut the wires to the lengths specified in the parts list, then strip and tin the ends before making the connections.

The leads to the 6-way terminal barrier are soldered to the various tags, while the supply leads are crimped and soldered to the polarised header pins. These pins are then inserted into the plastic header shell (watch the polarity).

Before soldering the supply lead to the DC socket, it's a good idea to test the current drain. To do this, you will need a 9-15V DC supply, a multimeter and some alligator clip test leads.

It's then simply a matter of applying power with your multimeter (set to mA) connected in series with one of the supply rails. The current drain should be in the region of 10mA. If it's significantly more, disconnect the supply and check for faults. If it is close to (or exactly), zero then you may have the supply leads transposed.

Once the wiring to the terminal barrier and the DC socket is completed, the board can be installed in the case. To do this, first attach an M3 x 15mm tapped Nylon spacer to each corner of the board using M3 x 20mm machine screws. Wind the spacers all the way onto the screws but don't tighten them – you must still be able to easily rotate the screw head.

Next, attach the three leads to screw terminal block CON3 (it's much more difficult to attach them once the board is in place). Having done that, route the soldered leads from the barrier terminal strip and the DC socket to either side of the case (see Fig.3), then lower the board into place until its mounting holes meet the integral pillars.

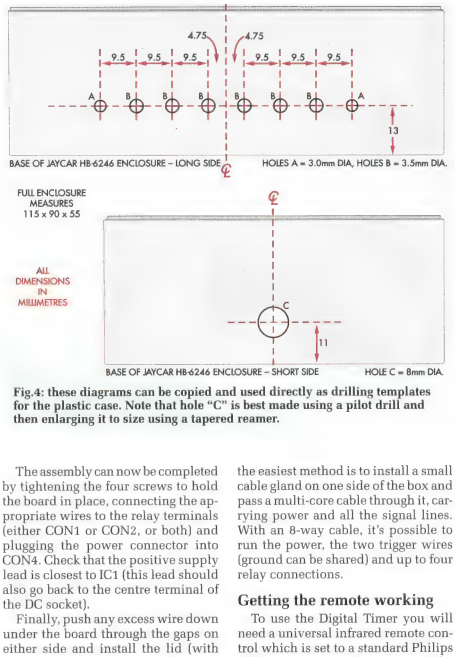


Fig.4: these diagrams can be copied and used directly as drilling templates for the plastic case. Note that hole "C" is best made using a pilot drill and then enlarging it to size using a tapered reamer.

The assembly can now be completed by tightening the four screws to hold the board in place, connecting the appropriate wires to the relay terminals (either CON1 or CON2, or both) and plugging the power connector into CON4. Check that the positive supply lead is closest to IC1 (this lead should also go back to the centre terminal of the DC socket).

Finally, push any excess wire down under the board through the gaps on either side and install the lid (with the neoprene seal pressed into its channel).

Waterproofing

Since the box is IP65 rated (ie, water and dust proof), it's possible to waterproof the timer if you wish to use it outdoors. However, because of the holes drilled for the barrier terminal strip and the DC socket, our prototype is more splash-proof than waterproof. If you like, you can apply silicone sealant to the inside of both connectors to improve this.

The difficulty of properly waterproofing the timer is that all connections must be made via IP65-rated connectors or cable glands. Perhaps the easiest method is to install a small cable gland on one side of the box and pass a multi-core cable through it, carrying power and all the signal lines. With an 8-way cable, it's possible to run the power, the two trigger wires (ground can be shared) and up to four relay connections.

Getting the remote working

To use the Digital Timer you will need a universal infrared remote control which is set to a standard Philips RC5 remote control code (this is the default in many cases).

The green LED in the timer will flash whenever an IR signal from the remote control is detected. To test whether you are using the right code, simply point the remote at the timer (make sure it is switched on) and press some of the numeric buttons.

The corresponding numbers should appear on the timer's 7-segment displays.

If they don't, either the timer has a fault or the remote control is set to the wrong code. Try setting the remote to other Philips codes until you find the correct one. For example, the Digitech remote control pictured in this article

A barrier terminal strip on one end of the case can be used to terminate the external trigger & reset inputs plus one set of relay contacts, or you can use it to terminate both sets of relay contacts. Don't forget the ratings sticker.

(Jaycar Cat. AR-1726) should be set to TV code 103.

Once it's working and the correct numbers appear, press the Power/Standby button on the remote to clear the display.

Adjusting the settings

Before putting the timer to work, you need to configure it for your application (unless you just want to use the default settings). The procedure is as follows:

(1) Default settings: for the first set of options, refer to Table 3. Decide on the default settings you want, then enter the corresponding digits in turn, from the first digit through to the sixth. When you have entered all six digits, press the mute button on the remote.

The display will now blank and your settings are saved. They can be updated at any time by repeating the above procedure.

An example will make this clearer. Let's say that you: (1) want the buzzer to sound at the end of the timing period, (2) want the relay to turn on at the end of the timing period (ie, for the duration of the alarm period), (3) want the trigger input active high, (4) the reset input active high, (5) the unit to count up when externally triggered and (6) the alarm period set to four minutes. In that case, it's just a matter of pressing 1, 2, 2, 2, 0, 4 on the remote in sequence, followed by the Mute button.

(2) Adjusting the brightness: the next step is to set the display brightness. This is done using the Volume Up (increase brightness) and Volume Down (decrease brightness) buttons. There are 32 possible levels and the brightness can be changed either when the timer is running or while setting the timing period.

Initially, you can just press some random number buttons to get digits on the display and adjust the brightness from there. That done, clear the display by pressing the Power/Standby button then press the Mute button. Each time the device is powered up after this, it will automatically load the set brightness level.

You can use the same procedure to change it again later, if necessary.

(3) Automatic timing: the final setting is the timing period you want programmed in for automatic triggering. Enter the time using the keypad, keeping in mind that the first two large

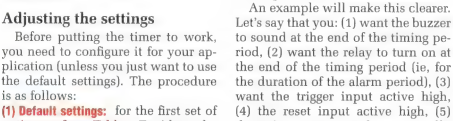


Fig.5: these labels should be attached inside the lid and to the panel above the barrier terminal strip using silicone sealant.

Table 3: Setting Up The Presets

Digit	Setting	0 means	1 Means (Default)	2 Means
First	Buzzer	Always off	On during alarm period	N/A
Second	Relay	Always off	On while counting	On during alarm per
Third	Trigger input	Disabled	Active low	Active high
Fourth	Reset input	Disabled	Active low	Active high
Fifth	When triggered	Count up	Count down	N/A
Sixth	Alarm period	Enter number of minutes (0-9)		

Controlling Mains Or High-Current DC

The relay used in this project is rated at 30VDC/2A and 125VAC/1A. However, as used here, **it should not be used to switch any AC voltage higher than 24V. DO NOT under any circumstances use the on-board relay to switch 230V AC mains appliances – that would be quite dangerous.**

To switch a mains load, you will need to use the on-board relay to trigger an external mains-rated relay (mechanical or solid state). This must be mounted and wired in a safe manner. **Don't attempt to do this unless you know exactly what you are doing and are experienced with 230VAC wiring!** You can also use an external relay if you need to switch high-current DC.

If you plan on adding an external relay, it's best to use one with a 12V DC coil and run the Digital Timer from a 12V DC supply. It is then simply a matter of connecting the timer's 12V rail to one of its internal relay's COM contacts (either on CON1 or CON2). The positive side of the external relay's coil is then connected to the corresponding NO contact, while the negative side goes directly to the negative output of the 12V DC supply. A reverse-biased diode should be connected across the external relay's coil to quench switching spikes.

Now when the internal relay switches on, it supplies power to the external relay's coil and it too switches on. The contacts of the external relay can then be used to switch on a mains device or supply power to a high-current DC load (provided these contacts are adequately rated).

Keep in mind that your 12V DC supply must be able to provide at least 100mA for the Digital Timer itself plus the rated coil current of your external relay. A 300mA plugpack supply should do the job quite nicely.

digits represent the number of hours, the next two the number of minutes and the two smaller digits the number of seconds. Then press the "1-" key on the remote (the one normally used to enter 2-digit TV station numbers).

This programmed time will now be placed in memory and recalled whenever the timer is started via its trigger input.

Using the timer manually

To use the timer manually, simply enter the timing period you want using the keypad, then press either the "Channel Up" or "Channel Down" button. If you press "Channel Up", the display will start at 00:00:00 and count up to the timing value you have entered. Alternatively, if "Channel Down" is pressed, the display will start at the timing value you have specified and count down to 00:00:00.

When the timing period ends, the alarm period will begin (unless it has been set to 0 minutes in which case the timer will immediately reset). When the alarm period expires, the unit resets automatically or you can press the Power/Standby button to reset it before it expires.

If you want to stop counting simply press the remote's Power/Standby button and the device will reset and go to standby mode. You can also pause the timer by pressing the pause button (assuming your remote control has it – it is actually a VCR function). To resume, press play (another VCR function).

Note that the buzzer is quite audible but not particularly loud once it is sealed inside the box. If you want to make it louder, drill some small holes in the lid immediately above the buzzer's location.

Finally, Fig.5 shows some labels which should be affixed to the inside lid of the case and to the panel immediately above the barrier strip terminal. These indicate the power supply requirements (and polarity) and also indicate the maximum voltage ratings for the relay contacts.

That's it! We are sure you can think of many uses for this project. SC

Charlieplexing

Earlier in the article, we referred to the method used to drive the LED displays as "charlieplexing", which is really just a special form of multiplexing. If you want to know more about charlieplexing, refer to our feature in the forthcoming September 2010 issue of SILICON CHIP.

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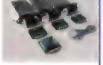

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SERVICEMAN'S LOG

Consumer gear that's faulty out of the box

It's not often these days that electronics gear is faulty out of the box but it does happen. Usually, we return the item for an exchange or refund but what happens if you've left it too long and lost the receipt into the bargain?

In this business, I get volunteered for all sorts of things – especially by Mrs Serviceman

Recently, at her request, I bought two digital mains timer switches for an elderly relative. Unfortunately, he left them unopened for several months and when he finally got around to trying them out, it soon became apparent that one of them was faulty. By then, the receipt had been well and truly lost and so Mrs Serviceman thought it would be a good idea for me to fix it.

After all, I was the one who had bought the timers, so it was my fault in the first place. That's logical.

While the digital timer portion of the device seemed to work fine, the actual mains switching did not. The working unit's relay would click each time the output was switched on or off via the manual control pushbutton. By contrast, the faulty device would click twice when it was switched on but there was no output at any time. In addition, there was no sound from the relay when it was switched off.

Luckily, this wasn't one of those plastic cases that is glued shut and has to be mangled to be opened. After removing a few screws from the back, it snapped open to reveal two PC boards. One of these was attached to the inside front face and carried the LCD, pushbutton switches and control electronics. The other board was attached to the rear of the case and carried the power supply circuitry and the mains relay.

I traced the layout of the main board and discovered that the power supply consisted of a 330nF X2 mains capacitor in series with the Active wire, followed by four 1N4004 diodes in a bridge rectifier configuration, then a 100µF 50V capacitor in parallel with a 36V zener diode to Neutral. A low-value 1W resistor is in series with the Neutral side of the circuit to limit the inrush current, while the X2 capacitor has a parallel high-value resistor to discharge it when the power is switched off.

In addition to the power supply and relay, the only remaining circuitry was an NPN transistor to drive the relay and a PC-mount trickle-charged 1.2V NiMH cell for powering the control board. The boards were connected via a 3-pin header and cable – two wires for powering the control board and one for driving the transistor that powers the relay.

Another interesting discovery was

that the relay was a 48V type, while the supply seemed to be regulated to 36V. Most relays are guaranteed to switch at approximately 75% of their rated voltage, which is why this circuit still works but I think I would have designed it a little more conservatively to allow more room for component tolerances.

Not wishing to risk applying mains power with the case open and not having a convenient source of 36VDC, I turned my bench supply up to its maximum 30V output and connected it across the zener diode. This proved to be enough to switch the relay but only when it was orientated so that gravity would assist its switching.

Fortunately, that was enough to allow me to determine that with this new power source, the unit worked correctly. Pressing the manual on/off button toggled the relay normally. So it seemed that the fault was in the power supply section.

Because they have a reputation for unreliability I decided to first replace the 100µF electrolytic capacitor. My reasoning was that it may be low in value and not providing sufficient current to keep the relay energised. However, that didn't help and the capacitor that had been removed tested OK.

The only other component that could explain this fault in the power supply was the 330nF X2 capacitor. However, these are designed to be reliable enough to be used across mains conductors, so surely that couldn't be it?

Despite my doubts, I removed the X2 capacitor and checked its value. It read 120nF which is just over a third of what it should have been! So now it was clear why the device was behaving as it was. While the supply was able to charge up to 36V initially, the voltage dropped significantly when the relay was turned on because of the higher impedance of the X2 capacitor.

In fact, it was dropping so far that the relay could not be kept closed. This explained the double click at turn on and explained why the output did not switch on properly. I replaced the X2 capacitor with a new one and it worked perfectly.

Did something cause this capacitor to fail? It's hard to say but its failure mode would appear to be consistent with the concept of X2 capacitor safety – it's better for it to lose some of its capacitance rather than go short circuit if it's going to be installed across the mains. However, I am suspicious that the capacitor used was of low quality. It weighed a fraction as much as its replacement!

My next two stories are from T. T. of Woorim, Qld who has had some interesting encounters with marine electronics. Here's how he tells them . . .

A shocking winch

In remote anchorages, a cruising yachtsman with some electrical knowledge gathers lots of friends, deals with lots of corroded wires and takes on a few challenging problems.

In one recent case, Don got me aboard his boat to look at his anchor winch. "Every time I pull up the anchor, I get a belt from the forestay," he said as he invited me up to the bow. "Go on, give it a try!"

Not being particularly partial to "belts", I gingerly took up the normal stance for winching up an anchor – one foot on the deck switch, one hand on the rail and the other hand holding the forestay so that one can hang over the side of the yacht to see what's happening. This shouldn't be too bad I reasoned – after all, it's a 12V system and the stay and rail are earthed, so how could I get a shock at all?

Anyway, I pressed the switch, the winch motor hummed, the chain clanked through the gypsy and . . . no shock. "Seems OK to me," I said, taking my foot off the switch. WHAM! That felt like several thousand volts alright! Don gave a satisfied grin. "Didn't believe me, did you?"

Inside the yacht, we took off the small cover between the front cabin and the chain locker to gain access to the winch motor. I then squeezed my head and shoulders through the

Items Covered This Month

- Faulty digital mains timer
- A shocking winch
- Faulty marine transceiver
- Timing the doors on a lift
- Sorting out a PA system

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"SEEMS OK TO ME," I SAID, TAKING MY FOOT OFF THE SWITCH...

opening to be greeted by the strangest winch motor I had ever seen. "Oh, its a converted aircraft starter motor . . . we needed something really powerful for all this chain we carry", Don told me.

Because I had received the shock when the current flow had stopped, it was obvious that the collapsing magnetic field had induced a high voltage in the motor's winding. It was similar to the way a high voltage is produced by a car's ignition coil when the supply is interrupted (eg, by a transistor switching off or, in ancient cars, the points opening).

This problem could occur with any motor but in this case, the particular installation made things worse. An aircraft motor has large multi-turn windings and is operated at high RPM through a gearbox, so that explained the source of the problem. The high induced voltage was sparking to the motor frame which was fixed to the deck just under the forestay.

I had a large diode left over from a solar panel installation and this was duly fitted across the supply wires at the motor terminals. This was normally reverse biased, just like a diode fitted across a relay coil, but would quench any back-EMF that was generated when the motor turned off.

Don had been imagining fitting thick pieces of insulation between the motor and the deck, or having the motor rewound because it was faulty. You can imagine his relief when a $2 diode did the trick.

Faulty marine transceiver

Radios are another common source of problems in the marine environment. After all, complex electronics and sea air are never a good mix.

Simon's VHF transceiver wouldn't transmit or receive. All the correct LEDs on the front panel were lighting at the right times and the display was fine, so my first thought was that it had to be the antenna. As a result, I removed the radio from the wooden panel above the navigation desk and unscrewed the PL259 plug from the antenna socket.

The problem was immediately evident – a greenish liquid was oozing from the plug, something I had seen several times before.

"The coax cable attached to the aerial at the top of the mast hasn't been sealed and water has wicked its way right down to the radio", I told him, "You'll need to replace the entire length".

Next, I examined the radio itself, as the salt water from the coax often gets inside the case and literally eats through component leads and PC board tracks. In this instance, only the socket itself was corroded and this was easily replaced.

A new length of RG213/U coaxial cable was also purchased but that was the easy part. Not quite so easy was the trip to the top of the mast, where you sit in an uncomfortable little bosun's chair suspended from the end of the mainsail halyard. What seems to be a lovely, calm anchorage at deck level isn't quite so attractive when you are 20 metres above the water, swaying several metres from left to right every few seconds, legs clamped around the mast and trying desperately not to drop that little grub screw.

A few turns of self-amalgamating tape (missing in the previous installation) sealed the joint and a quick "radio check" call to the Volunteer Marine Rescue about 15 nautical miles away confirmed that we were indeed back on the air.

An up-lifting story

This story comes from G. L. of Carrum Downs in Victoria. Did you know that you could alter the timing of lift doors by jumping up and down? Neither did he, as he explains . . .

As a long-time reader of Silicon Chip, I have read many Serviceman's Log columns and have great empath with his trials and tribulations, esp cially when it comes to dealing v customers.

In my case, I work as a Lift Me ic, installing and servicing lif involves both electrical and r cal work and as you can ima of the work is fairly routi

Servicing Stories Wanted

Do you have any good servicing stories that you would like to share in *The Serviceman* column in Silicon Chip?

If so, why not send those stories in to us? In doesn't matter what the story is about as long as it's in some way related to the electronics or electrical industries, to computers or even to car electronics.

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and be sure to include your full name and address details.

all – the following tale is from my time in our service department.

One day, I was issued a call-out to investigate a lift that apparently had timing issues with the way the doors opened and closed. This was an older building with relay-logic lift controllers. In these units, the door dwell time (ie, the time the door stays fully open) is set by an RC network. This period could alter over time due to the electrolytic timing capacitor getting a bit leaky or even due to mechanical binding in the relay, depending on its type.

On arrival at the job, I was met by the employee who had reported the fault and his manager. Now, at this point I should point out that this building was inhabited by state government public servants. What's more, these two particular public servants must have trained in lift technology because they seemed to think they knew something about the subject – perhaps even more than I!

In due course, the three of us entered the troublesome lift so that the expert could show me just what his extensive testing had revealed. According to him, if you let the doors open and close by themselves without human intervention, they stayed open "a very long time". I nodded my head at this and instructed him to proceed with his story.

He then stated, that he could make the doors close faster using a special technique that he had researched and tested over the last few days. I must say that his manager appeared suitably impressed with this highly-skilled employee but I wasn't so sure.

"OK", I said, "please show me how you speed up the doors", whereupon he walked to the rear righthand corner of the lift and proudly announced "Watch this!"

The lift door opened and he immediately jumped up and down until it started to close! "See it closes quicker if you jump!" His manager looked even prouder now, especially as this guy had spent days working this out.

I was not so impressed with his claim and immediately proceeded to explain how the door timing actually worked. It was a waste of time, as they both quickly assumed the look of my Labrador when I talk to it. All they heard was "blah-blah capacitor, blah-blah relay, blah-blah discharge time" – in short, they didn't really try to comprehend a word I said.

They then pointed out that I was wrong, with nice smirks on their faces. After all, what would I know? I was just the lift mechanic.

"OK", I said, "let's just try this. We'll let the door open and close naturally and time it with a watch". Well, we did this and this produced a 6-second dwell time (ie, the door stayed open for six seconds). " Now" I said, "let's time it using your jump method to reduce the door open time".

Our expert jumped up and down for all he was worth but to their amazement, it was still six seconds! We had to repeat this quite a few times until they eventually got the idea that jumping up and down does not alter a capacitor's discharge time!

By now, the smirks had disappeared and the manager apologised for wasting my time. And as they trotted off back into the building, I heard the manager jokingly threaten to reassign his jumping colleague "to the mail

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room for all eternity". In some ways, it would have been a fitting punishment.

My next story comes from a contributor in Western Australia and concerns a PA system. Here it is . . .

Sorting out a PA system

A comment in an earlier issue about "a mate who knows someone who knows someone" reminded me of a curious PA system fault in a country church. Country people often struggle to get access all kinds of services, including electronic expertise. However, there's always a local "mate" to do the job for you.

In this case, the PA had been installed by one such mate, who was asked to do the job on the basis that he "fiddled with electronics". Some time later, when I came on the scene, I found that the PA system had a bad hum and that it sounded rather "muddy". Apparently, everyone had put up with it because they thought it was the best they could expect, especially when a mate had installed it.

My first thought was that the hum was most likely caused by a broken microphone lead on the offending input. Checking the mike sockets revealed unbalanced 6.35mm mono jacks wired with ordinary coax cable – great for TVs and 2-way radios but not so good for balanced audio inputs. The offending input's cable also happened to be the longest run (into inaccessible roof space) and was also placed right on top of mains cable.

The easiest option was to try to convert this run into a balanced line using a balancing transformer at the mike socket. This reduced the hum quite a bit but not as much as I'd hoped. Low-level hum was still audible and the occasional electric motor whine also intruded. Apparently, the shield was picking up more noise than the centre conductor, leaving some imbalance.

This now left the difficult option, which was to completely rewire the system with twin-shielded cable and replace the mono jacks with standard XLR connectors.

Re-wiring with twin-shielded cable involved erecting scaffolding so that it could be safely run across a high ceiling. It was duly installed after some effort and the coax cable to the remaining inputs was replaced as well. In addition, the 6.35mm jacks were all replaced with standard XLR sockets. Problem solved, or so I thought.

Well, it wasn't. Not only was the hum still there but when I moved the microphone around, there was even more hum than before – except this time on a different channel to the one the mike was plugged into! This was starting to look very strange. I rechecked the wiring of the newly-wired XLR sockets to make sure I hadn't accidentally unbalanced what should have been a balanced lead but all was good.

Where to now? Perhaps by solving a hum problem on one channel I'd either introduced or exposed a similar problem on the other. However, the wiring to this input was a much shorter run and not near any mains cable. And in any event, it was now twin-shielded cable.

By now, it was starting to look like an earthing problem in the amplifier. A quick multimeter check on all its XLR sockets revealed that pin 1 was earthed in each case, which is normal – except that nothing was behaving normally.

Since just any earth isn't good enough as far as low-level audio is concerned, it was all starting to look too difficult and the thought of purchasing a new amplifier quickly crossed my mind. However, this job was a labour of love and besides that, the amplifier was now misbehaving worse than before I started. This was rather embarrassing and so I persisted.

The PA amplifier itself was modular, with the XLR sockets on a separate input board at the back of the chassis. This is connected to the main board by a ribbon cable, so there were several possibilities here for a problematic earth connection.

I now spent a very long time examining the PC tracks through a maggy lamp but this revealed nothing obvious – not that dry joints are always obvious. Tapping, prodding and poking also revealed nothing so all that was left was to resolder all the earth connections in the low-signal circuitry in the hope that this would fix the problem.

And that's when I came across a possible dry joint on a link from the preamplifier section earth to the main earth run on the PC board. As a result, I resoldered all the earth connections and that fixed the hum problem. The amplifier is now as quiet as a mouse, with not a trace of hum.

So was the original unbalanced microphone cabling capable of working hum-free, with the problem only in the PA amplifier? It's quite possible that it had all worked correctly when it was first installed, with the amplifier developing its dry-joint fault some time later.

That aside, resoldering the earth connections in the amplifier and using twin-shielded cabling has certainly done the trick. What's more, the new cabling will provide the best possible immunity to noise pickup.

Now all I have to do is solve the question as to why our local expert would connect both low impedance and 100V line speakers to the amplifier when the handbook says not to. SC

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Refer: Silicon Chip Magazine August 2010

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An environmentally friendly DMM with rechargeable batteries that can be charged from the built-in solar panel, 12-36VDC or from mains power. Never have to buy batteries again.

- Category: Cat III 600V
- Display: 2000 count
- Size: 179(H) x 88(W) x 39(D)mm

QM-1546 WAS $119.00

$95.00

SAVE $24.00

Autoranging Pocket DMM

A handy test instrument worthy of any professional tradesman or handyman's tool kit. This unit has an easy one finger dial selector on the front leaving your other hand free.

- Fixed leads
- Shockproof
- Case included
- Auto power-off
- Display: 5000 count
- Category: Cat II 600V / Cat III 300V
- Basic VDC accuracy: 0.500%

QM-1544 WAS $59.95

$34.95

SAVE $25.00

Trade Quality 1000V Digital Multimeter

A true RMS DMM purpose built for professional applications. With an ergonomic slimline yet robust design, it has overload protection, easy battery replacement, and comes supplied with a protective holster and test lead. A trustworthy instrument for apprentices and seasoned tradesmen alike.

- Display: 4000 count
- Category: Cat IV 600V
- Dimensions: 164(L) x 82(W) x 44(D)mm

QM-1623 WAS $199.00

Limited Stock

$129.00

SAVE $70.00

Multifunction Environment Meter with DMM

new

A multi-function environment meter that combines the functions of a sound level meter, light meter, humidity meter and temperature meter. Typical sound applications include checking acoustics of recording studios, auditoriums and professional hi-fi installations. The light and humidity meters are ideal for video photographers, greenhouse and hydroponic setups, etc. Others who should find this meter essential include interior designers, factory and office managers, record and archive keepers, schools, hospitals, laboratories and, of course, universities.

- 4000 count
- Cat III 300V
- Dimensions: 170(H) x 78(W) x 48(D)

QM-1594

$129.00

Semiconductor Component Analyser

new

Intelligent semiconductor analyser that offers simple identification and testing for a variety of 2 or 3-pin devices. Type and lead identification as well as forward voltage, test current and other parameters for transistors.

- Automatic type identification of Bipolar Junction Transistors (BJTs), Darlington, MOSFETs, JFETs, triacs, thyristors, LEDs, diodes & diode networks
- Automatic pinout identification
- Gain and leakage current measurement for BJTs
- Silicon and germanium detection for BJTs
- Forward voltage and test current
- Dimensions: 100(W) x 71(H) x 27(D)mm

QT-2216

$129.00

Professional Laser Distance Meter

Distance, area, volume or indirect measurement, this does it all in metres, feet or inches. It also adds, subtracts and takes min/max measurements. Invaluable for architects, estimators, builders or renovators. Battery and case included.

new

- Backlit LCD
- Laser accuracy
- Dimensions: 110(L) x 47(W) x 28(H)mm

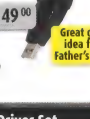
QM-1621

$199.00

Sound Level Datalogger

new

Designed for recording and logging sound pressure level measurements for quality control, illness prevention, acoustic design or any other type of environmental sound measurement in domestic or industrial applications. The memory is able to record up to 129,920 samples with A or C weighting at intervals from 1 second to 24 hours and downloaded to a PC for later analysis. Modified to calculate SPL via proper log averaging rather than the inaccurate arithmetic average used on the original design. Battery and windsock included.



- USB interface
- Over-range indication
- System requirements: Windows 2000, XP, Vista.
- Dimensions: 140(L) x 28(W) x 21(H)mm

QM-1599

$149.00

Great gift idea for Father's Day

15 Piece Micro Driver Set

This handy set will fit the bill for all those microscopic fasteners we come across in modern electronics. The handles are colour coded for easy identification and they come in a storage case.

The set contains:
Slotted: 1mm, 1.4mm, 1.8mm, 2.4mm
Phillips: #000, #00, #0, #1
Torx: T5, T6, T7, T8
Hex: 1.5mm, 2mm, 2.5mm
Drivers: 105mm long
Case size: 192(L) x 130(W) x 26(H)mm

TD-2069

$24.95

All Savings are based on Original RRP
Limited stock on sale items.

DON'T JUST SIT THERE, BUILD SOMETHING

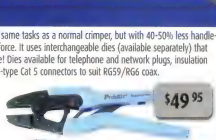
hot DEALS TO WARM YOU UP THIS WINTER!

Ergonomic Supercrimp Tool

This super heavy-duty ergonomic crimper is designed to perform the same tasks as a normal crimper, but with 40-50% less handle-force required, and a pressure adjustment dial for variable actuation force. It uses interchangeable dies (available separately) that can be quickly and easily changed. Buy only the dies that you require! Dies available for telephone and network plugs, insulation terminals, BNC/TNC connectors to suit RG58/59/62 coax, and even F-type Cat 5 connectors to suit RG59/RG6 coax.
TH-1950 $49.95

Dies to suit:

6P6C Telephone Connectors	TH-1952	$17.95
8P8C Computer Network Connectors	TH-1953	$17.95
Fully Insulated Crimp Terminals	TH-1954	$17.95
BNC/TNC Coax Connectors for RG58/59/62	TH-1955	$17.95
F-type Cat 5 to suit RG59/6	TH-1956	$17.95
Non-insulated Crimp Terminals 22-12 AWG	TH-1957	$17.95
SMA/Fibre Optic	TH-1958	$17.95
PV Connectors	TH-1959	$29.95



TH-1952 TH-1956 TH-1958

$49.95

Desoldering Braid Dispenser Gun

An integrated desoldering tool for service and production work. Saves time and money by reducing waste.

- ESD safe
- Safer - no more burned fingers
- Replacement braid: NS-3043 $9.95 NS-3042 WAS $79.95

$44.95
SAVE $35.00

Lithium Grease - 400g

Long-lasting heavy duty lubricant grease for bearings, sliding mechanisms, battery terminals, chains, sprockets or other moving parts. White in colour so it forms a kind of thick, milky sea in the lubricated area. Reduce friction, protects against corrosion.
NA-1015

$9.95

IP56 Rated Pushbutton Switches

IP65 rated for use in harsh environments. Rated for 14V 10A, with 22mm mounting hole. Only red is illuminated.

Black SPST Momentary	SP-0756	$6.95
Red SPST Momentary Illuminated	SP-0757	$8.95
Black SPST Push-On Push-Off	SP-0758	$6.95
Red SPST Push-On Push-Off Illuminated	SP-0759	$8.95

Limited Stock

Engine Start Switch

- Keyless engine start for track or street.
- Illuminated momentary action pushbutton
- Rated for 12VDC 50A
- Mounting hole 22mm

SP-0773

$19.95

SPST Heavy Duty Pushbutton Marine Switch

SPST momentary action, brass body with large chrome-plated actuator. Can accommodate panel thickness of up to 22mm. Mounting hole 16mm, screw terminals.
SP-0701

$19.95

IP66 Industrial ABS Enclosures

Gasket seals, stainless steel hardware and IP66 rated for use in industrial, marine and other harsh environments. The closures have a locking catch that engages to positively hold the lid closed until disengaged. Each enclosure includes a 1.8mm galvanised chassis for mounting DIN rail, switchgear, relays or circuit breakers. A size for any application.

OPAQUE COVER:
Small 125(L) x 125(W) x 75(D)mm
HB-6400 Was $16.95 **Now $11.95** Save $5.00
Medium 175(L) x 125(W) x 75(D)mm
HB-6402 Was $29.95 **Now $24.95** Save $5.00
Large 200(L) x 200(W) x 130(D)mm
HB-6404 Was $34.95 **Now $29.95** Save $5.00

TRANSPARENT COVER:
Small 125(L) x 75(W) x 75(D)mm
HB-6410 Was $18.95 **Now $13.95** Save $5.00
Medium 175(L) x 125(W) x 75(D)mm
HB-6412 Was $32.95 **Now $27.95** Save $5.00

FROM $11.95

SAVE $$$

Great gift idea for Father's Day

Rocker Switches

SPST IP56 Rated Rocker Switch

Waterproof SPST large rocker actuator for harsh environment applications.

- Rated for 240VAC 10A
- Mounting hole 34 x 15mm

SK-0993

$4.95

Illuminated IP56 Rated Rocker Switch

IP56 rated, large rocker actuator.

- SPST
- Illuminated red
- Rated for 12VDC 20A
- Mounting hole 20.5 x 37mm

SK-0997

$12.95

IP65 SPDT Centre Off Rocker Illuminated Switch

IP65 rated, illuminated switch for automotive and marine applications. Illuminates one side red and one side green.

- On-Off-On
- Rating: 14VDC, 21A
- Cutout size: 34 x 21mm

SK-0999

$12.95

Heavy Duty Toggle Switches

Rated for 277VAC 20A with 11.5mm Mounting hole.

SPST	Cat. ST-0581	$4.95
SPDT	Cat. ST-0583	$5.45
DPDT	Cat. ST-0585	$7.95
DPDT Centre off	Cat. ST-0586	$7.95

Also available:
12VDC 20A SPST Illuminated Red
Cat. ST-0587 $4.95

C&K Toggle Switches

Quality US C&K toggle switches with solder tags.

SPDT Mini Toggle Switch
ST-0396 $6.45
SPDT Centre Off Mini Toggle Switch
ST-0397 $6.95
DPDT Mini Toggle Switch
ST-0398 $8.95
DPDT Centre Off Mini Toggle Switch
ST-0399 $9.45

2 Channel USB Oscilloscope

Plug 'n Play USB technology means this oscilloscope is easy to setup and use. The included software includes a chart recorder, function generator, logic generator, logic analyser, and spectrum analyser, all in one easy to use package. See website for more.

- Oscilloscope, spectrum analyzer
- Sample rate: 100 Hz - 200 kHz
- Input voltage -20 - +20 V
- ADC capacity: 10 bits

QC-1930 Was $299

$199.00
SAVE $100.00

Limited stock on sale items.

All Savings are based on Original RRP

www.jaycar.com.au

Jaycar Electronics
Better, More Technical

Wind Generators

Always at the forefront of alternative energy technology, we're pleased to offer this new range of wind turbine generators. As well as the 200W model we now have a super-compact 300W version, and a big 500W unit for those who want to generate some serious power. All models feature external charge controllers with three-phase AC output, so you can install a long cable run without worrying about DC voltage drop.

NOTE: All wind generator models are supplied without mounting tower and associated mounting hardware.
WARNING: These wind generators are suitable for permanent terrestrial installations ONLY!

200W 12VDC
- Number of Blades: 3
- Included: generator, blades, tail, hub, nose cone, external charge controller

MG-4520 $399.00

FROM $399.00

Check out our new 300W Lightweight Wind Generators!

300W 12VDC MG-4580 $599.00
300W 24VDC MG-4582 $599.00
Features: moulded, compact, efficient blade design, are lightweight, have neodymium magnets, and the charge controllers are built into the generator heads.
- Number of Blades: 3
- Included: generator, blades, tail, hub, nose cone

Spare parts available. See our catalogue or website for more details

500W 24V
- Number of Blades: 3
- Included: generator, blades, tail, hub, nose cone, charge controller

MG-4540 $999.00

Halogen Replacement Bulbs

A range of drop-in replacement halogen globes that will fit standard bayonet or Edison screw fittings, use only 2/3 the energy, last for over 1000 hours and, being halogen maintain the same warm quality of light that everyone is used to. Sizes for any room or use:

$5.95 PK 2

42W is 60W equivalent Edison Screw	SL-2795	$5.95
42W is 60W equivalent Bayonet	SL-2796	$5.95
70W is 100W equivalent Edison Screw	SL-2797	$5.95
70W is 100W equivalent Bayonet	SL-2798	$5.95

3 Piece LED Puck Light Kit

3 x 1W puck lights that can be surface mounted or recessed to fit into your décor. They're powered by a single plugpack with a distribution block on a 2 metre cable, and each light has its own 600mm cable, so you can easily install them yourself.

- Fashionable cool white colour
- More than 30,000 hours life
- Power supply 12VDC 1A
- Light size: 72(Dia) x 28(H)mm

SL-3894

$149.00

Switchmode Plugpacks

These switchmode plugpack adaptors are slim in size, lightweight, and feature manually selectable variable voltage outputs. All are MEPS compliant and come supplied with 7 plugs and a USB output socket. (MP-3318 does not include USB socket)

7.2W 3 - 12VDC with USB Outlet
- Dimensions: 69(L) x 39(W) x 31(H)mm

Cat. MP-3310 $19.95

18W 3 - 12VDC with USB Outlet
- Dimensions: 69(L) x 39(W) x 31(H)mm

Cat. MP-3312 $24.95

FROM $19.95

18W 3 - 12VDC with USB Outlet
- Dimensions: 69(L) x 39(W) x 31(H)mm

Cat. MP-3314 $29.95

27W 3 - 12VDC with USB Outlet
- 7 output plugs with USB outlet
- Dimensions: 96(L) x 50(W) x 30(H)mm

Cat. MP-3316 $34.95

25W 9 - 24VDC with USB Outlet
- Dimensions: 96(L) x 50(W) x 30(H)mm

Cat. MP-3318 $34.95

IP68 3-Core Flex Joiner

Designed to enable the joining of mains 3-core flex cables while providing a robust and waterproof connection. Includes 3-way terminal block, but will also accommodate any connector that fits within the internal dimensions of the housing.

- IP68 rated
- AS/NZS3100
- Voltage rating: 250VAC
- Current rating: 16A max
- Accepts cables 6 - 10mm dia

PS-4068

$29.95

12VDC Car Cigarette Lighter Socket 4 Way Splitter

With the plethora of 12VDC plug appliances now available, your car's single cigarette lighter socket seems somewhat insufficient. This cigarette socket splitter enables you to power up to four 12VDC plug appliances at once. From our range alone you can plug in a laptop adaptor, a heated travel mug, a sine wave inverter, and a rechargeable LED torch. Plus it features a USB port to charge your iPhone® or other USB gadget. Mounting hardware included.

- 12VDC plug with 12m lead
- 4 x 12VDC socket outputs
- 1 x 5VDC 1A USB port
- 10A max

PS-2019

$19.95

Limited Stock

Vehicle LED Daytime Running Lights

These Euro styled superbright LED bulbs will turn on automatically on ignition, making your car more noticeable on the road. With a lifespan of 50,000 hours, these long life and energy saving DRLs are a much better daytime alternative than using your fog lights or low beam headlights. Flush-mounted brackets are included for easy installation and directional tilt-adjustment.

- Energy efficient 12V 6.1W
- Emark 87R certificate
- Each lamp measures 190(W) x 30(H) x 43(D)mm

SL-3419

$149.00

IP67 LED Landscape Spotlights

IP67 rated for complete protection against the weather and can even be mounted in a water feature or rock pool! Being LED, they use very little power and will last for thousands of hours. Each can be mounted on a surface or on the stout spike and thrust into the ground in a convenient location. Each has a 5m length of cable and extension cables are available. 1W or 3W types.

- Provides natural-looking light
- Energy efficient
- Equivalent to a 50 watt halogen

FROM $19.95

1W IP67 LED Garden Spotlight	SL-2755	$29.95
3 x 1W IP67 LED Garden Spotlight	SL-2756	$59.95
Power Supply - 12VAC 12W	SL-2757	$24.95
Power Supply - 12VAC 24W	SL-2754	$39.95
Extension Cable - 5m Screw Lock	SL-2759	$19.95

80W Portable Fold-Up Solar Panel

Fold it away in the carry bag when not in use, then when you set up camp just fold it out so your batteries are being charged. A stand is included so you can position the panel for optimum solar capture; and charge controller is fitted to ensure batteries are correctly charged. Excellent for your next camping, 4WD or boating trek.

- Rated voltage: 12V
- Voltage at pmax: 17.3V
- Current at pmax: 4.64A
- Open circuit voltage: 21.5V
- Short circuit current: 5.1A
- Dimensions:
  Open: 1090(W) x 623(H) x 36(D)mm
  Folded: 545(L) x 623(W) x 73(D)mm

ZM-9130 Normally $649.00

Great gift idea for Father's Day

$599.00 SAVE $50.00

Special Introductory Price

Better, More Technical

All Savings are based on Original RRP
Limited stock on sale items.

To order call 1800 022 888

DON'T JUST SIT THERE, BUILD SOMETHING

hot DEALS TO WARM YOU UP THIS WINTER!

Outdoor IP65 Rated Tri-tech Microwave/PIR Sensor

new

Most PIRS are generally not suitable for outdoor use. The dual lenses, use of two synchronised PIR sensors and microwave technologies, plus the movement detection algorithm built in reduces false alarms and with the IP65 rating makes this sensor suitable for outdoor security applications. It also has NO and NC alarm outputs, tamper switch and LED alarm trigger indicator. See website for specifications.

- All-in-one motion sensor
- Automatic background analysis
- Selectable PIR and microwave sensitivity
- 12VDC power
- Dimensions: 168(H) x 95(W) x 65(D)mm

LA-5042

$149.00

Swivel Bracket to suit: LA-5043 $19.95

12V 100Ah Deep Cycle Gel Battery

Deep-cycle gel performance for solar installations and other alternative energy systems.

- Capacity: 100Ah
- Initial charge current: 30A
- Cycle voltage: 14.4 - 15V
- Standby voltage: 13.5 - 13.8V
- Weight: 31.5kg
- Dimensions: 330(L) x 173(W) x 223(H)

$499.00

SB-1695 Full range of SLA & GEL batteries in stock - see in store

Low Voltage Battery Isolator

With microprocessor control, this indispensable device monitors the output voltage of any 12V lead-acid battery. If the terminal voltage drops below 11.9V, the battery will be automatically disconnected. Essential for boats, camping, caravans, RVs, 4WD, solar power systems etc.

- High cranking capacity - 800A
- High input/output current - 200A
- Low power consumption - 15mA
- 3 year warranty
- Mounting hardware included
- Dimensions: 85(H) x 55(W) x 35(D)mm

MB-3678

$99.95

Colour Coded Key Finder

new

Remember putting your keys down but cant quite pinpoint where? This little gadget will help you with your problem in no time. Simply press the colour coded button allocated to your keys on the main unit and the matching receiver will beep so you can find those missing keys. The base unit can be placed on a counter top or be wall mounted. Stand included.

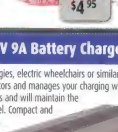
- Transmits radio signal up to 25m away
- Key fobs incorporate LED flashlight
- Required 3 x AA Batteries

XC-0353

$49.95

Keyring Keyfinder with LED Torch

Ever misplaced your keys and needed them in a hurry? This brilliant device will generate a beeping sound when it detects a whistle. It will work effectively within a 3 metre radius. Also doubles as a handy keyring torch! Batteries included.



- Uses 2 x LR44 batteries
- Size: 52(L) x 40(W) x 15(W)mm

XC-0351

$4.95

3 Stage 48V 9A Battery Charger

Suitable for golf buggies, electric wheelchairs or similar applications. It monitors and manages your charging with three different stages and will maintain the optimum charge level. Compact and lightweight. Includes output cables with eye terminals to attach to your battery.

- Switchable charging modes
- Short circuit, output current, polarity and thermal protection
- LED charge status indication
- Digital Charge Display
- Input: 190 - 260VAC
- Output: 48VDC @ 9A max
- Dimensions: 298(L) x 112(W) x 60(H)mm

MB-3628

$499.00

Great for Golf Buggies!

SHADOW 3-Point Engine Immobilising Car Alarm Deal

This high quality engine immobilising car alarm surpasses the AS/NZS 4601:1999 standard and boasts a range of features including:

- Micro-processor controlled technology
- 2 button 2 channel code hopping remotes
- External relay output for the third immobilisation point
- Panic button personal safety feature
- Heavy duty 2 x 40 amp immobiliser relay circuits
- Horn or siren output
- Remote central locking (if car fitted with central locking)

LA-8970 $139.00

Siren to suit **Shadow Immobilising Car Alarm**

- Multi-Tone 20 watt Battery Back-Up Siren with security key shut-off
- Shock Sensor (adjustable sensitivity settings)
- Bonnet Pin Switch (protects engine bay from tamper)
- Supplementary Installation booklet

LA-8975 $49.95

SPECIAL DEAL

Buy Both for $138.95 & Save $50

Gear For The Outdoors

These fantastic X-Glow torches utilise Cree® high performance LEDs, which are renown for providing superior light and longer globe life than other brands. Incredibly energy efficient, Cree® LEDs produce a clear smooth beam of brilliant white light with minimal energy lost through residual heat. These X-Glow torches feature robust water resistant aluminium casings for heavy duty use, and they will even cold start in sub-zero temperatures.

Save $$$

80 Lumens	ST-3372	Was $47.95 **Now $29.95** Save $18
136 Lumens	ST-3374	Was $64.95 **Now $34.95** Save $30
176 Lumens	ST-3376	Was $69.95 **Now $39.95** Save $30

Limited Stock

1 Watt LED Torch with In-built Car Charger Plug

new

Low battery? No worries, this super-bright 1 watt LED torch conveniently recharges in your car's cigarette lighter socket. With a robust aluminium alloy housing it can take a fair amount of abuse and still shine as brightly as the day you bought it.

- Dimensions: 160(L) x 35(Dia)mm

ST-3381

$19.95

190 Lumen CREE® LED Powered Torch with Adjustable Lens

new

With a massive light output of 190 lumens, a tactical switch and multiple light modes every 4WD should have one in the glovebox. Adjustable beam with 5 zoom options.

- Requires 3 x AAA batteries

ST-3456

$39.95

Rechargeable Air Pump

From party balloons and pool toys to larger air mattresses and rubber dinghies - this high-volume low-pressure rechargeable air pump will have the job done in no time. Recharged via mains power or car charger, its portable cord-free operation makes this a must-have accessory for your beach and camping inflatables.

new

$39.95

- Inflation and deflation port
- Includes hose and two air nozzle fittings
- Mains adaptor (240VAC) and car charger (12VDC) included

GH-1119

Electronic Transformers for LED Lights

new

These electronic transformers are designed to be used with LED lighting products that take a 12V power source, for example our LED MR16 replacement globes, and provide the same kind of efficient power delivery and compact size as a normal electronic transformer. They deliver a constant 12VDC and feature short circuit, over temperature, over load and spike protection. 10W and 20W models available:

10 Watt	MP-3360	$19.95
20 Watt	MP-3362	$24.95

www.jaycar.com.au

Limited stock on sale items.

All Savings are based on Original RRP

Jaycar electronics

Better, More Technical

POWER

USB & HARD DISK DRIVE DOCKING STATIONS

4-Port USB 3.0 Hub

USB 3.0 hub with four ports. 4.8Gbps data rate. 10X times faster than USB2.0.

$79.95

• Dimensions: 85(L) x 32(W) x 18(H)mm
XC-4947 Due late August

Dual 2.5/3.5" SATA HDD Docking Station - USB 3.0

A blazing fast USB 3.0 ready dual SATA docking station for the home or office. Dock two 3.5 or 2.5 inch SATA drives or one of each, and in a flash you can back up gigabytes, terabytes or petabytes of information without the hassle of installing hard drives in enclosures or in the PC.

• Dimensions: 130(W) x 61(H) x 103(D)mm
XC-4697

$99.00

Note: hard drive not included

USB 3.0 SATA 2.5"/3.5" HDD Dock

A 2.5"/3.5" SATA dock for USB 3.0 enabled desktop PCs and laptops. USB 3.0 boasts theoretical speeds of up to 4.8Gbps, that's ten times faster than its USB 2.0 predecessor. This dock is particularly useful for computer technicians, IT professionals and those of you who download a lot and need to swap between drives frequently.

$79.95

• Compatible with Windows XP/Vista/7/Mac 9.X and higher
• Dimensions: 145(L) x 94(W) x 82(H)mm
XC-4696

Note: hard drive not included

600VA 375W Line Interactive UPS

Compact and completely self-contained, this is the ideal backup solution for your data or other important equipment. It has 3 surge-protected outlets as well as 3 outlets backed up by the UPS. It also has RJ11 ports for protecting phone or fax lines.

$119.00

• Cold start feature
• Software included
• Rating: 375W, 600VA
• SLA battery: 7Ah
• Supply voltage 220 to 280VAC
• Backup time: 3 min at full load
• Recharge time: 10 hrs
• Output waveform: Step sine wave
• Dimensions: 268(L) x 180(W) x 80(H)mm
MP-5222

Ethernet over Power - 200Mbps

If you don't have the time for crimping cables and installing wallplates, Ethernet over the existing power cables is a great solution. The will convert Ethernet packets from the Ethernet port to powerline communication packets (PLC packets), which run on regular home power lines, then converts them from PLC packets back to Ethernet packets. A simple way to extend speedy wired networking around the house.

$179.00
SAVE $10.00

• Data rate: Up to 200Mbps
• Data link protocol: HomePlug AV
YN-8350 WAS $189.00

Industrial IP68 USB Keyboard

Dustproof & waterproof to IP68, so if it should ever get dirty simply wipe clean with a sponge. Perfect for industrial, food & beverage, laboratories, garages and even outdoor use. It also comes with a silicone sleeve for added protection. Anti-bacterial rubber construction.

$65.00
SAVE $34.00

• Full-sized QWERTY layout
• USB connectivity
• Windows 2000/XP/Vista
• Measures 440(L) x 138(W) x 12(H)mm
XC-5141 WAS $99.00

New USB Leads

High Quality USB 2.0 Leads - 2.0m

High quality USB 2.0 leads for your PC peripherals, professional audio or camera equipment. Superior shielding protects against potential electromagnetic interferences and ensures data continuity.

USB A (male) to USB B (male)	WC-7790	$14.95
USB A (male) to USB-Mini B (male)	WC-7792	$14.95
USB A (male) to USB A (male)	WC-7794	$14.95
USB A (male) to USB-Micro B (male)	WC-7796	$14.95

High Quality IEEE1394 Cables - 1.8m

This range of high quality IEEE1394 cables boast 24K gold plated connectors, 99.9% oxygen free copper conductors and are shielded against EMI. Ideal to obtain faultless data streams.

B 9-pin to B 9-pin Cable	WC-7630	$19.95
B 9-pin to A 4-pin Cable	WC-7632	$19.95
B 9-pin to A 6-pin Cable	WC-7634	$19.95

USB 3.0 Adaptors

Plug B to Socket A Adaptor
PA-0930 $12.95
Micro B Plug to Socket A Adaptor
PA-0931 $12.95
Socket A to Socket A Gender Changer
PA-0932 $12.95
Plug Micro B to Socket B Adaptor
PA-0933 $12.95

5 Port 100/1000 N-Way Gigabit Switch

A high performance switch that offers a cost-effective means of increasing network performance and reducing congestion. It manages the transmission of data packets on the network & enables simultaneous connections between several machines without interfering with data being exchanged on the other connections. 9VAC power pack included.

$59.95
SAVE $20.00

• Standards compliance: IEEE 802.3, IEEE 802.3u, & IEEE 802.3ab
• Size: 130(W) x 103(D) x 27(H)mm
YN-8089 WAS $79.95 Limited Stock

3 Port Motorised Retracting USB Hub

Just touch the top and your USB hub will rise from the surface of your desk to do your bidding. Touch it again and it lowers itself back into place and out of the way. It has 3 USB 2.0 ports and also acts as a cable grommet to keep all your computer cables neat and tidy.

$12.95
SAVE $2.00

• Powered by USB
• Mounting hole: 75mm
• Mounting depth: 70mm
• Diameter: 92mm
XC-4877 WAS $14.95

2.5" SATA HDD Enclosure - USB 3.0

Take advantage of the massive speed increase of USB 3.0. Slot your 2.5" SATA HDD into this enclosure and when connected to a USB 3.0 port of a computer you will experience speeds up to 10 times faster than USB 2.0.

$59.95

• Includes one 1.1m USB 3.0 Micro B to Male A Cable
• Locking screws included
• Dimensions: 77(W) x 113(L) x 14(D)mm
XC-4684

5.5" Graphics Tablet

Using a graphics tablet is completely natural, more comfortable and far more accurate than a mouse, with higher resolution and pressure sensitivity. The pen has user defined buttons and "hotspots" around the border of the tablet. Paint, draw, write or touch up. Absolutely essential tool for graphics designers, photographers or other creatives.

$69.95

• Battery & software included
• Windows 2000, XP, Vista or Mac
• Dimensions: 205(W) x 190(H)mm
XC-0356

2.4GHz Wi Fi Yagi Antenna

Ultra-compact unobtrusive indoor antenna for wireless networking at home or in a small office. Termination is by SMA connector on 1m lead.

$29.95

• Frequency range: 2.4 -2.4835GHz
• VSWR: – 2.0
• Impedance: 50 ohm
• Gain: 8dBi
• Polarisation: Vertical
• Base: 85(L) x 47(W)mm
AR-3282

USB Powered Extension Lead with 4 Port Hub

Extend your printer or any other USB device as far as 10 metres away from your PC. A 4-port hub adds extra flexibility. Powered by USB from the host computer.

$49.95

XC-4122

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2 Channel Pro DJ Mixer

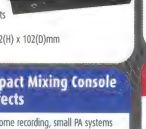
new

The ideal mixer to learn on. Two channels each with RCA inputs for CD or other line level source and a set of dedicated phono inputs. The BPM counter is capable of accurately measuring the beats per minute of almost any kind of dance music automatically and works equally well with a CD player or a turntable.

- Level meters on each channel
- 2 band EQ on each channel
- Phono and line level inputs
- Mic and headphone outputs
- Effects loop
- Line level preamp outputs
- Selectable CF curve
- Dimensions: 330(W) x 22(H) x 102(D)mm

AM-4206

$149.00



Dual Channel UHF Wireless Microphone

new

Suitable for professional and stage use, this UHF diversity wireless microphone system features 16 user-selectable channels with easy infra-red pairing on each microphone provide interference-free transmission. It also has phase locked loop (PLL) circuitry for frequency stability. The system includes 2 microphones with batteries and receiver unit in 19" rack-mount chassis. See website for full specifications.

- Power: 12 - 18VDC
- Dimensions: 420(L) x 210(W) x 45(H)mm

AM-4120

$499.00

Also available: **UHF 2 Channel Wireless Microphone** AM-4122 $269.00

LED DMX Spotlights

new

Team any of these LED DMX-controlled lights with a controller or software for complete control over your stage, party or DJ lighting setup. Each is 240V powered, individually addressable via DIP switch and includes a mounting bracket.

Budget 61 LED 4 Chanel DMX Spotlight SL-3420 $99.00

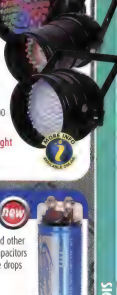
- Dimensions: 180(L) x 170(Dia)mm

All Aluminium Par 46 5 Channel 94 LED DMX Spotlight SL-3422 $139.00

- Dimensions: 300(L) x 135(Dia)mm

Par 64 5 Channel 94 LED DMX Spotlight SL-3424 $169.00

- Dimensions: 245(L) x 195(Dia)mm



8 Channel Compact Mixing Console with Digital Effects

The ideal small mixer for home recording, small PA systems etc. This is a well-featured little unit with high and low mic inputs, separate EQ, gain and pan controls, aux send and return for effects, recording outputs and phantom power.

new

- Four mono channels with high & low impedance inputs
- 2-band EQ on all mono channels
- Gain, aux send and pan controls
- 2 stereo channels
- Phantom power (48V)
- Headphone output
- Dimensions: 270(W) x 270(H) x 50(D)mm

AM-4204

Limited Stock

$299.00

Battery Powered 2.4GHz AV Sender

Provides hassle-free sharing of Audio and Video signals all over your house, office, or shop where power and space are a consideration. Wireless and compact, both transmitter and receiver operate on battery power. Connection to the AV source is via 3.5mm to RCA composite video and audio lead.

- 2 x 1m leads included
- Each unit requires 2 x AA batteries
- 85mm wide

AR-1852 Was $79.95

$26.95

SAVE $53.00

1 Farad Capacitor

new

High farad capacitors act as surge current reservoirs for your amplifiers and other electrical equipment. Integrate these capacitors into your audio system to avoid voltage drops from high transient current peaks.

- Gold plated terminals
- Mounting brackets and hardware included
- Digital voltage display
- Dimensions: 260(H) x 75(Dia)mm

RU-6754

$99.00

6.5mm Mono to Speakon Cable 3m

Stage quality 6.5mm mono to Speakon cable for connecting small PA systems. 3m, super flexi cable.

WA-7108

new

$16.95

Budget 4 Channel DVR with 4 Cameras

This is an excellent DVR that is ideally suited to smaller surveillance installations around the home or office. It uses MJPEG video compression and can store over 150 hours of video on its 250Gb hard drive. Recording setup is simple and various trigger modes can be set across the day including include timer recording, motion detection, and manual operation. Supplied with 4 x weather resistant colour day/night cameras, connecting leads and wireless remote.

- 4 x colour camera inputs
- 1 x composite video output
- Frame rate 25fps (Quad mode)

QV-3063 Was $599

$499.00

SAVE $100.00

2.1mm Illuminated Polarity Sensing DC Connectors

new

Simplifies installation of CCTV cameras, access control and other security applications. These 2.1mm DC connectors detect and indicate the polarity of power connections with integrated LEDs. They also shine brighter as voltage increases. 3-30 VAC/VDC range, 1 metre lead length.

Available in two models:

DC Plug WQ-7288 $4.95

DC Socket WQ-7289 $4.95

Dual Siren Personal Alarm with LED Torch

new

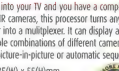
Deter thieves and attackers with its loud dual 130dB sirens and powerful independent torch function which will strobe when the alarm is activated. Simply pull the rip-cord to pull out the pin. Fantastic for travellers.

- Includes 4 x LR44 batteries
- Dimensions: 105(L) x 28(W) x 15(H)mm

LA-5181

Also available **Personal Mini Alarm with LED Torch** LA-5183 $9.95

$14.95



Quad Processor with 2 CMOS Colour Cameras & Remote Control

Add a monitor or plug into your TV and you have a complete surveillance system. With 2 colour IR cameras, this processor turns any standard TV or monitor into a multiplexer. It can display a single camera view, or multiple combinations of different camera views including one or two picture-in-picture or automatic sequencing.

Dimensions: 105(L) x 85(W) x 55(H)mm

QV-3095 WAS $349.00

Limited Stock

$149.00

SAVE $200.00

Colour Dome Camera Kit with 2 Wire Connection

A simple 2 wire combined arrangement for power and video make this system a snap to install. The system uses a CMOS image sensor with 350TV line resolution and will automatically sense signal cable tampering or incorrect wiring and alert you with a warning signal. Kit includes camera, signal processor, connecting cable, and mains adaptor.

QC-3264 WAS $129.00

- Outdoor IR version (IP56 rated) also available - QC-3266 $89.00

$69.00

SAVE $60.00

Limited stock on sale items.

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www.jaycar.com.au

Jaycar Electronics

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Anatomy Models

4D Human Skin Model

Perfect skin section model up to medical educational level. Includes removable hair and skin layers with extra acne parts. A fantastic educational tool for schools and medical practices.

- 25 pieces included
- Approx 200mm high

GG-2377

$24.95

1:1 Scale Human Heart Model

Deluxe cutaway life-size heart anatomy model that's perfect for medical educational purposes. Includes detachable tricuspid valve and mitral valve as well as detailed parts of the aorta, pulmonary artery, superior vena cave, inferior vena cave and septum.

- Display stand included
- Approx 185mm high

GG-2378

$49.95

Note: All recommended for ages 8+

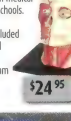
4D Human Head Model

Learn all about how the brain works and the structure of the skull. A fantastic cutaway model for education in medical practices and schools.

- 14 pieces included
- Display stand included
- Approx 185mm high

GG-2379

$24.95



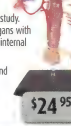
4D Female Reproductive System Model

Female reproductive system model for education and medical study. Includes detachable organs with cross section parts and internal details.

- 16 parts with stand and assembly guide
- Approx 240mm high

GG-2388

$24.95



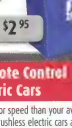
Jaycar Cooler Bag

Take a few frosty ones to the cricket - or a bottle of chardonnay if you like to bowl from the Paddington end. Lined with insulation and holds a 6-pack.

- Size: 260(W) x 260(H) x 120(D)mm

HB-5005

$2.95



Digital Luggage Scale

Pack one of these for the next trip and avoid nasty surprises at the check-in counter.

- Requires 2 x AAA batteries
- Capacity: 40kg
- Tare and auto-off
- Backlit LCD
- Overload and low battery indication
- Size: 122(L) x 85(H) x 25(W)mm

QM-7232

$19.95

Kid's Digital Photo & Video Camera

The kids will enjoy hours of creativity with this digital photo & video camera. The robust design can withstand heavy duty play. It has a 16MB internal memory and can capture up to 120 still photos or up to 50 seconds of video.

- Requires 4 x AA batteries
- Camera driver software and USB cable included
- Windows 2000, XP & Vista compatible
- Suitable for ages 3+

QC-3188

$49.95

1:10 Scale Remote Control Brushless Electric Cars

Featuring a much higher motor speed than your average RC car (3300 rpm/Volt), these brushless electric cars are more efficient, so your battery pack lasts longer. Both models are ready to race and have high-efficiency brushless motors with electronic speed controllers, four wheel drive, independent suspension, super-tuff Lexan bodies, rechargeable batterypacks and digital proportional remote control units.

Brushless Touring

- Length: 360mm
- Wheelbase: 260mm
- Track: 200mm
- Gear ratio: 6.25:1
- Battery: 7.2V, 2000mAh

GT-3674 Was $299.00

$269.00

SAVE $30.00

Truggy

- Length: 460mm
- Wheelbase: 275mm
- Track: 250mm
- Gear ratio: 1:8.038
- Battery: 7.2V, 2000mAh
- Recommended for ages 12+

GT-3676 Was $329.00

$279.00

SAVE $50.00

Great Gift Idea For Father's Day

Spare parts available separately

2Robot Chess Board

Equipped with a robotic arm and an enhanced high-speed program, it can teach you to play as well as improve your skills.

- Suitable for novice to experienced players
- 128 levels including training, tournament & problem solving levels up to mate-in-6 moves
- Programmed in accordance with the International Chess Rules
- Board size: 380(W) x 380(D) x 40(H)mm

GT-3516

WAS $299.00

$229.00

SAVE $70.00

Limited Stock

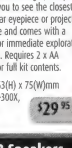
Power Microscope Kit

With reflecting and transmission light, this power microscope will enable you to see the closest details under a monocular eyepiece or projection screen. Easy to assemble and comes with a ready made specimen for immediate exploration of the microscopic world. Requires 2 x AA batteries. See website for full kit contents.

- Dimensions: 95(L) x 163(H) x 75(W)mm
- Power 50X-100X, 150X-300X, 300X-600X microscope

QC-3243

$29.95



USB Cassette Deck

Record cassette tracks to your computer via USB or play back through the built-in SW speaker. You can also run the line level outputs to an external amplifier and use it as a component cassette deck.

Dimensions: 178(L) x 72(H) x 178(W)mm

GE-4054

$79.95

Mini PC/MP3 Speakers

Plug in your MP3 player or any other audio source and the 30mm speakers will provide more than enough volume to bop along to. Powered by batteries or 6VDC plugpack (not included).

- Requires 4 x AAA batteries
- Dimensions: 167(W) x 54(H) x 32(D)mm

XC-5177

$14.95

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Arrival dates of new products in this flyer were confirmed at the time of print. Occasionally these dates change unexpectedly. Please ring your local store to check stock details. Prices valid to 23rd August 2010.

All savings are based on original RRP

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PRODUCT SHOWCASE

"Environment" multimeter does light, sound, temperature, humidity, frequency . . . etc!

The new Digitech QM1594 Multimeter from Jaycar Electronics does much more than measure your usual voltages, currents, resistance, etc.

Dubbed a "multifunction environment meter" this versatile meter may be the only one you will ever need as it also handles light levels to 40,000 Lux, sound levels from 35 to 100dB (C weighted, 30-10kHz), frequency (5Hz-10MHz), temperature 0 to 50°C (or with supplied K-type temperature probe -20 to 1300°C), relative humidity 33-99% . . . along with the more "usual" ranges of AC/DC voltage, AC/DC current (including µA ranges), resistance, capacitance, diode check, etc.

Priced at $129, it is supplied with the test leads shown at right (including thermocouple), 9V battery and instruction manual. It's available now from all Jaycar Electronics stores, resellers and the web Techstore.

Contact:
Jaycar Electronics
(All stores and web Techstore)
Tel: 1800 022 888
Website: www.jaycar.com.au

Stomp Boxes: Designed to handle it!

Hammond Electronics' new 1590 STOMP die-cast aluminium enclosures are the housings of choice for leading stomp box manufacturers.

Stomp boxes, also known as guitar effect pedals, are used by electric guitarists to produce preset effects such as distortion, wah-wah, delay, chorus and phaser.

The 1590 STOMP boxes are a rugged, easy-to-machine die-cast aluminium enclosure well able to cope with the demanding on-stage environment in which they will be used. Available in two sizes, 112 x 60 x 27mm and 119 x 94 x 34mm and a variety of vibrant, bright colours: blue, green, orange, light grey and red.

Contact:
Hammond Electronics Pty Ltd
11-13 Port Rd, Queenstown, SA 5014
Tel: (08) 8240 2244 **Fax:** (08) 8240 2255
Website: www.hammondmfg.com

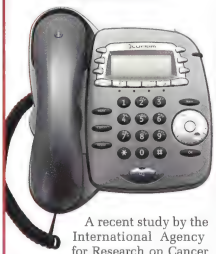
Keystone Components Mini Catalog

More than 125 new products for use with SMT or THM applications are featured in this 16-page mini catalog from Keystone Electronics.

Products include an expanded selection of battery hardware; contacts, clips, holders and retainers for coin cell and button cells batteries; new, multi-use fuse holders and clips for mini and standard auto blade fuses; top quality, insulated terminals, pins and jacks with PTFE bushings and insulators; standard USB, micro USB, mini USB Type A and B plugs and sockets for both SMT and THM mounting in USB 2.0 and USB 3.0 configurations.

Contact:
NPA Pty Ltd
10 Gray St, Kilkenny, SA 5009
Tel: (08) 8263 2733 **Fax:** (08) 8268 1455
Website: www.npa.com.au

New BlueSIM phone combats mobile phone radiation



A recent study by the International Agency for Research on Cancer (IARC) has found that people who talk on their mobile phones for 30 minutes a day are up to 40% more likely to develop glioma, a common type of brain cancer.

The BlueSIM phone takes the mobile phone away from your head. Developed by an Australian company, the BlueSIM phone works with any Bluetooth-enabled mobile phone (including smart phones). Once the Bluetooth signal of a mobile phone is recognised by the BlueSIM handset, the quick link process begins and use of the BlueSIM handset can commence.

From this point forward the mobile phone is recognised as a paired device with the BlueSIM handset, allowing calls to be made to and from the BlueSIM handset via the mobile phone connection. In this regard, the BlueSIM phone becomes an extension of a mobile phone.

The BlueSIM phone is available in selected stores throughout Australia and has a recommended retail price of $299.00

Contact:
The Dualsim Phone Company
Tel: 02 9756 6224 **Fax:** 02 9756 6242
Website: www.bluesim.com.au

Ultrasonic Cleaner

By JOHN CLARKE

Most readers would know that you can obtain small ultrasonic cleaners for jewellery and similar small items. So why not a much larger version? It would be great for cleaning automotive and other mechanical parts, fabrics which cannot be machine washed, ornate bric-a-brac and a host of other hard-to-clean items.

Anyone who has ever needed to clean the parts for a carburettor, differential, gearbox or any other greasy and intricate parts must have often wished for an easier way.

Generally you dunk the parts in a container of kerosene, dieseline detergent or whatever, to soak for a while and then you return to the task with various brushes and implements to scrape off the grease and other gunk. It is a dirty and tedious task.

But what if you could dispense with all that brushing and scraping? If you could just drop the components in a tank of suitable solvent, press a button and then come back later to remove the parts in sparkling clean condition?

Our ultrasonic cleaner is designed to do exactly that job. It uses a high power piezoelectric transducer and an ultrasonic driver to literally blast away the dirt and grime with ultrasonic energy.

The solvent might be kerosene or hot water and a wetting agent such as a detergent. At low drive levels the solvent conducts the ultrasonic signal throughout the bath. At higher power levels, the ultrasonic wavefront causes cavitation which causes bubbles to form and then collapse. This is shown in Fig.1.

As the wavefront passes, normal pressure is restored and the bubble collapses to produce a shock wave. This shock wave helps to loosen particles from the item being cleaned.

The two "halves" of the project: the controller at left and the ultrasonic transducer, potted in a length of pipe, at right.

Features

- 12V plugpack powered
- Automatic timeout
- Adjustable timeout
- Start button
- Rugged transducer

Cleaning a coffee-stained stainless steel tray in our "bath" (actually an old plastic cistern – see page 65). You can't see the bubbles being generated in this photo – they're too small – but they are certainly there.

The size of the bubbles is dependent upon the ultrasonic frequency and is smaller with higher frequencies.

Industrial ultrasonic cleaners tend to use frequencies between 20kHz and 50kHz while cleaners for small parts typically use frequencies above 50kHz.

Our ultrasonic cleaner sweeps the frequency range from about 19kHz to 42kHz to produce cavitation bubbles of varying sizes. The frequency is varied with an irregular pattern to avoid a constant low frequency sub-harmonic in the cleaning bath or tank. Variation of the sub-harmonic frequency reduces the impact of resonances in small items being cleaned that may otherwise cause them to disintegrate.

This variation in frequency also prevents standing waves in the cleaning bath that can produce cavitation in one area but no cavitation in another area. This can lead to irregular cleaning action of a component.

Actual power delivered is dependent upon the resonant frequency of the piezo transducer. For the Silicon Chip Ultrasonic Cleaner, maximum power delivered by the transducer is at about 40kHz which is the resonant frequency of the specified piezo ultrasonic transducer.

The Ultrasonic Cleaner can be set to run for between 30 seconds and 10 minutes.

Alternative sweep pattern

An alternative sweep pattern is available that sweeps over a frequency range of around 12kHz, centred on the 40kHz resonance. This produces a higher agitation level in the cleaning bath due to the transducer frequently running through its resonance. This alternative sweep pattern should be for intermittent use only. Which sweep pattern is best depends on the component being cleaned and the type of contamination.

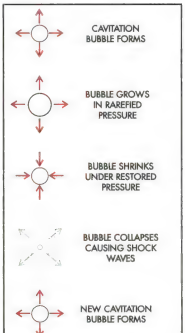


Fig.1: the ultrasonic cleaning process. It's all about causing shock waves in the cleaning solvent to literally "shake off" the dirt and grime. You *can* do this manually – but the ultrasonic transducer does it 40,000 times each second!

The driver for our Ultrasonic Cleaner is housed in a small plastic case. This connects to the piezoelectric ultrasonic transducer itself using a length of sheathed 2-core mains-rated cable. The piezoelectric transducer is housed in a PVC fitting that covers and insulates the terminals from accidental contact. This is necessary because the transducer is driven at a high voltage which could cause a nasty shock if you come into contact with it.

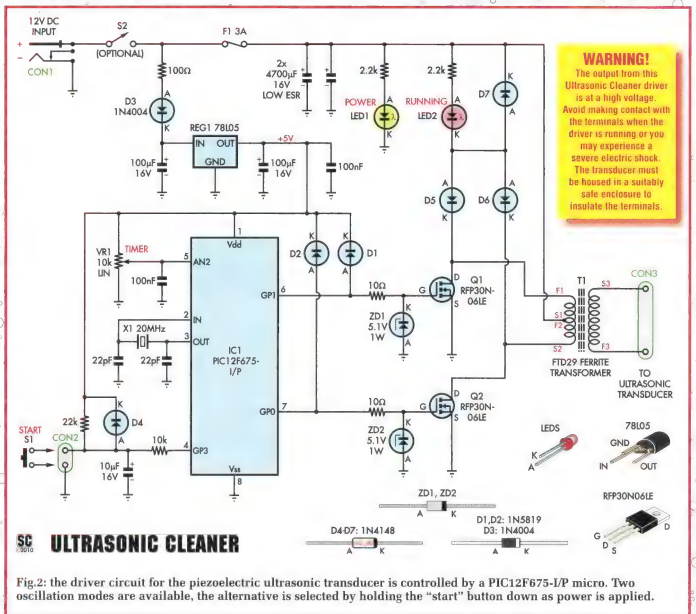
The piezo transducer and housing can be directly immersed in the ultrasonic bath or tank. Alternatively the transducer can be glued to the outside of the bath using epoxy resin for deeper baths.

Circuit details

The circuit of our Ultrasonic Cleaner (fig.2) is relatively simple due to the use of an 8-pin PIC12F675-I/P microcontroller, IC1. This drives the piezoelectric transducer via two Mosfets, Q1 & Q2 and transformer, T1. The microcontroller also provides the timer and the start functions.

Crystal X1 sets the microcontroller to run at 20MHz. This frequency allows the ultrasonic drive to be shifted in small increments amounting to 320Hz at around 40kHz.

Outputs GP0 and GP1 provide complementary gate drive signals for Mosfets Q1



WARNING!
The output from this Ultrasonic Cleaner driver is at a high voltage. Avoid making contact with the terminals when the driver is running or you may experience a severe electric shock. The transducer must be housed in a suitably safe enclosure to insulate the terminals.

Fig.2: the driver circuit for the piezoelectric ultrasonic transducer is controlled by a PIC12F675-I/P micro. Two oscillation modes are available, the alternative is selected by holding the "start" button down as power is applied.

& Q2. Since these outputs only swing from 0V to 5V, Q1 & Q2 are logic-level Mosfets. Standard Mosfets require gate signals of at least 10V for full conduction but logic-level Mosfets will fully conduct with much less. For the RFP30N06LE Mosfets specified, the on-resistance between drain and source is a mere 75mΩ at 20A at a gate voltage of 3V. The on resistance drops further to around 23mΩ at 20A at the higher gate voltage of 4.5V. The Mosfets are rated at 30A continuous.

Q1 & Q2 are driven alternately and these in turn drive the separate halves of the transformer primary which has its centre tap connected to the +12V supply. When Mosfet Q1 is switched on, current flows in its section of the transformer primary winding.

Q1 remains on for less than 50us depending on the frequency and is then switched off. Both Mosfets are then off for a few microseconds before Q2 is switched on. Q2 is then switched on for the same duration as for Q1 and then both Mosfets remain off for a few microseconds before Q1 is switched on again. The gap when both Mosfets are off is the "dead time" and it allows each Mosfet to fully switch off before the other is switched on.

The alternate switching action of the Mosfets generates an AC square wave in the secondary and since the primary/secondary turns ratio is 11.25:1, the secondary winding delivers about 250VAC to the piezoelectric transducer at between 19kHz and 42kHz.

Mosfets Q1 and Q2 include overvoltage protection which clamp any drain voltage that exceeds 60V. This clamping is required since a high-voltage transient occurs when the transformer primary winding is switched off. Protection for the gate of each Mosfet is provided using 5.1V zener diodes. Although the Mosfet

Specifications

Power Requirements	12V at 2.5A
Transducer voltage	250VAC square wave
Frequency range	Main mode is 19kHz to 42kHz with irregular variation
Alternative frequency Range	34 to 44kHz
Timeout Adjustment	30s to 10m

gate is only driven from a 5V signal, the high transient voltage at the drain can be coupled into the gate via capacitance between gate and drain. The 5.1V zener diodes prevent a higher voltage driving IC1's GP0 and GP1 inputs which could damage them.

Further protection is provided for GP0 and GP1 using diodes D1 and D2, which are in parallel with the chip's internal protection diodes. These clamp and carry the current if the voltage at these pins goes above about 5.3V.

Running indication

LED2 indicates when the Mosfets are switching on and off. When Q1 is switched on, diode D6 can power LED2 via the 2.2kΩ resistor from the 12V supply. When Q2 is switched on the LED is driven via D5. When both Q1 and Q2 are off, the LED is not driven.

When either Q1 or Q2 are switched off, the high voltage from the transformer primary winding at the Mosfets' drain can couple through diodes D5 or D6 due to capacitance. Diode D7 clamps the voltage to 0.7V above the 12V supply to protect LED2.

Timer

IC1 also performs the timer function. This switches off all drive to the Mosfets after a preset time period, set by the position of potentiometer VR1. VR1 is wired across the 5V supply with the voltage at the wiper monitored by IC1 at the AN2 (pin 5) input. IC1 converts the voltage into a digital value which is used as a basis for the timeout.

The maximum timeout of 10 minutes is set with the wiper of VR1 at 5V, with shorter timeouts as VR1 is reduced. The lowest practical setting is about 30s. When the potentiometer is set to its minimum position, the timer will not run and the Mosfets are kept off. If the potentiometer is rotated to this minimum position during the running of the timer, the timer will also be switched off, turning off the Mosfets.

Starting the ultrasonic drive is initiated by pressing the start switch. Normally, the GP3 input (pin 4) is held at 5V via a 22kΩ pull up resistor. When the switch is pressed, this input is pulled to 0V and signals IC1 to run the ultrasonic drive.

When S1 is released, the 10µF capacitor across the switch charges up to 5V via the 22kΩ resistor. Diode D4 discharges the capacitor when power is switched off and the 5V supply rail drops to 0V.

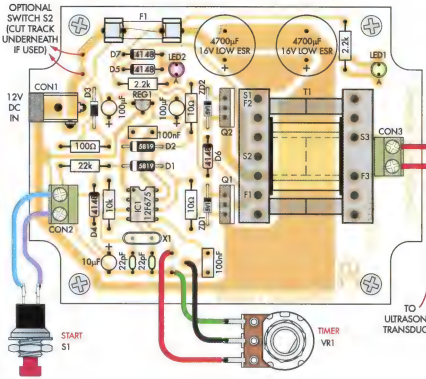
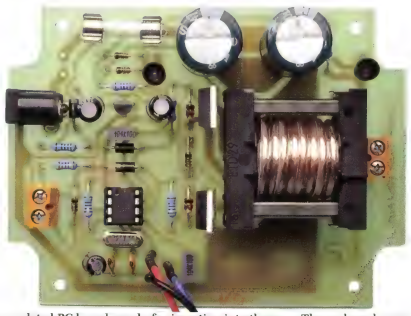


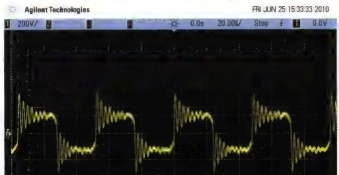
Fig.3: component overlay for the Ultrasonic Cleaner. All components (except the start button, timer pot and transducer!) are mounted on a single-sided PC board. If an on/off switch is required, the copper track must be cut between the S2 pins.

5V power for IC1 is derived from the 12V supply via a 100Ω resistor, reverse polarity protection diode D3 and 5V regulator, REG1. The supply to REG1 is filtered with a 100µF capacitor, while the 5V output is bypassed using 100nF and 100µF capacitors.

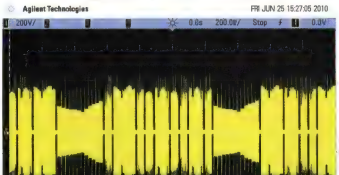
Reverse polarity protection for the power section of the circuit is via a 3A fuse (F1), along with the integral reverse diode within each of Mosfets. These diodes conduct current through the primary windings of transformer T1, effectively clamping the supply voltage at -0.7V, protecting the 4700µF electrolytic capacitors from excessive reverse voltage.



The completed PC board, ready for insertion into the case. The on-board power switch (S2) is not used here – the two PC pin holes (top left) are empty and the thin copper track underneath is intact.



The voltage waveform appearing the ultrasonic transducer as it is swept over a range of frequencies. In this case it is shown at 20.8kHz. Note the high peak-peak voltage of 600V.



Taken at a low sweep speed, this waveform shows the transducer driven with bursts of different frequencies. In this case the maximum peak-peak voltage is 900V. Danger!!

The 12V 2.5A plugpack includes foldback current limiting where current at voltage below 12V is reduced from its maximum rating of 2.5A. With a short circuit the current limit is around 0.5A. The fuse is unlikely to blow and power dissipation in the Mosfets is around 0.35W total. This does not cause any harm to the Mosfets, the transformer or the capacitors.

The fuse is included to prevent the PC board tracks from fusing should the transformer be wound incorrectly or if one of the Mosfets fails as a short circuit.

Power-on indication is via LED1, powered via a 2.2kΩ resistor from the 12V supply.

Construction

The Ultrasonic Cleaner is constructed on a PC board coded 04208101, measuring 104 x 78mm. It is mounted in an IP65 ABS box with clear lid, measuring 115 x 90 x 55mm. The clear lid allows the power and running LEDs to be seen without having to drill extra holes.

The PC board is designed to mount onto the mounting bushes within the box. Make sure the PC board is shaped to the correct outline so it fits into the box. It can be filed to shape if necessary using the PC board outline shape as a guide.

Begin construction by checking the PC board for breaks in tracks or shorts between tracks and pads. Repair if necessary. Check the hole sizes are correct for each component to fit neatly. The screw terminal holes and transformer pin holes are 1.25mm in diameter compared to the 0.9mm holes for the ICs, resistors and diodes. Larger holes again are used for the DC socket and fuse clips.

Normally, power can be switched on and off by switching the plugpack at the power point. However, if you prefer to have a separate switch for the Ultrasonic Cleaner, we have provided the option to include a power on and off switch (S2) that is wired between two PC stakes on the PC board.

If you are not using the switch then the PC stakes do not need to be installed. If you are using a switch, then the PC stakes are installed and the thinned track between the PC stakes is broken using hobby knife. PC stakes are required to be installed for the three connection points for VR1.

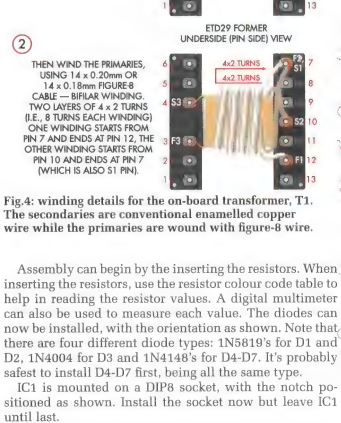


Fig.4: winding details for the on-board transformer, T1. The secondaries are conventional enamelled copper wire while the primaries are wound with figure-8 wire.

Assembly can begin by the inserting the resistors. When inserting the resistors, use the resistor colour code table to help in reading the resistor values. A digital multimeter can also be used to measure each value. The diodes can now be installed, with the orientation as shown. Note that there are four different diode types: 1N5819's for D1 and D2, 1N4004 for D3 and 1N4148's for D4-D7. It's probably safest to install D4-D7 first, being all the same type.

IC1 is mounted on a DIP8 socket, with the notch positioned as shown. Install the socket now but leave IC1 until last.

The crystal (X1), the DC socket and the two 2-way screw terminals can be installed next, with the screw terminals oriented with the opening toward the outside edge of the PC board. Q1 and Q2 are mounted so that their metal tabs

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face the transformer and are about 25mm above the PC board. REG1 can also be mounted now. None of these components require heatsinks.

The LEDs are mounted with the top of each LED 30mm above the PC board. Again, take care with orientation: the anode has the longer lead. Capacitors can be mounted next ensuring the electrolytic types are oriented correctly. The two main supply electrolytics (4700µF/16V) must be low ESR types.

Winding the transformer

Fig.4 shows the transformer winding details. The primary winding uses standard polarity-marked figure-8 wire, either 14 x 0.20mm or 14 x 0.18mm, wound in two layers. The secondary uses 0.25mm enamelled copper wire wound in two layers with a layer of insulation tape between the first and second layers.

Start by winding the secondary winding. First, remove the enamel from the one end of the 0.25mm enamelled copper wire (use some fine emery paper or a hobby knife to scrape it off). Pre-tin the wire end and wrap it around pin 4 on the underside of the transformer bobbin and solder close to the bobbin. Now close-wind 45 turns (ie, side-by-side) until the windings reach the opposite end of the former. The direction of winding does not matter. Cover the windings in a layer of insulation tape.

Continue winding back over the first layer, in the same direction as before (ie clockwise or anticlockwise) to complete 90 turns. Terminate the wire onto terminal 3 in the same way as was done for terminal 4.

The primary winding, made from the figure-8 cable, is first stripped of insulation at about 10mm from the ends and the two wires are soldered close to the bobbin at pin 7 and pin 10. Place the wire with the polarity stripe to pin 7. Now wind on four turns making sure the wire lies flat without twisting so the striped wire stays to the left.

The four turns should fully fill the bobbin and the next four turns will be on the next layer (there's no need for insulation tape between them). Terminate the striped wire end onto pin 12 and the other wire to pin 7.

Once wound, slide the cores into the former and secure with the clips. These clips push on to the core ends and clip into lugs on the side of the bobbin. The transformer can be installed into the PC board holes and soldered in place. Install T1 on the PC board noting that

Parts List – Ultrasonic Cleaner

1 PC board 104 x 78mm, coded 04208101
1 IP65 ABS box with clear lid, 115 x 90 x 55mm (Jaycar HB6246 or equivalent)
1 panel label 84 x 80mm
1 12V 2.5A plugpack
1 50W Ultrasonic transducer with 40kHz resonance. Type 09020180 (Jaycar)
1 65mm PVC DWV (Drain, Waste and Vent) end cap
1 65mm PVC pipe 40mm long to suit end cap
1 ETD29 transformer with 2 x 3C85 cores a 13-pin former and 2 retaining clips (T1)
1 2.5mm PC mount DC socket (CON1)
1 SPST momentary closed panel switch (S1)
1 SPDT toggle switch (S2) (optional)
1 3A M205 fuse (F1)
2 M205 fuse clips
2 2-way screw terminals (CON2,CON3)
1 DIP8 IC socket for IC1
1 knob to suit VR1
2 cables gland for 6mm cable
1 20MHz crystal (X1)
3 PC stakes (for VR1 terminals on PC board)
2 PC stakes (optional for S2)
2 solder lugs (Ultrasonic Transducer terminals)
2 M4 x 10mm screws (Ultrasonic Transducer solder lugs)
2 M4 nuts (Ultrasonic Transducer solder lugs)
2 4mm star washers (Ultrasonic Transducer solder lugs)
4 M3 x 6mm screws (PC board to case)
1m twin core mains flex (Ultrasonic Transducer lead)
1 300mm length of 14 x 0.20mm or 14 x 0.18mm fig-8 wire (primary T1)
1 3m length of 0.25mm enamelled copper wire (secondary T1)
1 300mm length of black hookup wire (S1 and VR1)
1 50mm length of red hookup wire (VR1)
1 50mm length of blue hookup wire (VR1)
1 100mm length of yellow hookup wire (optional for S2)
1 240mm length of 2mm heatshrink tubing (VR1 and PC stakes and S1 terminals)
1 40mm length of 5mm heatshrink tubing (Ultrasonic transducer terminals)
1 40mm length of 5mm black heatshrink tubing (LED1,LED2 covering)

Semiconductors

1 PIC12F675-I/P programmed with 0420810A (IC1)
1 78L05 5V regulator (REG1)
2 RFP30N06LE 30A 60V Logic level Mosfets (Q1,Q2)
2 1N4733 5.1V 1W zener diodes (ZD1,ZD2)
1 1N4004 1A diode (D3)
4 1N4148 switching diodes (D4-D7)
2 1N5819 1A Schottky diodes (D1,D2)
2 3mm LEDs (LED1,LED2)

Capacitors

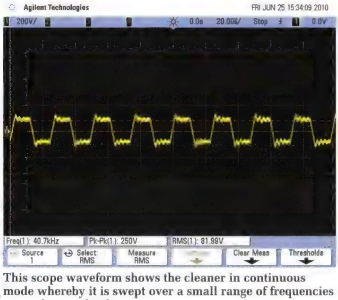
2 4700µF 16V low ESR
2 100µF 16V
1 10µF 16V
2 100nF MKT polyester
2 22pF ceramic

Resistors (0.25W 1%)

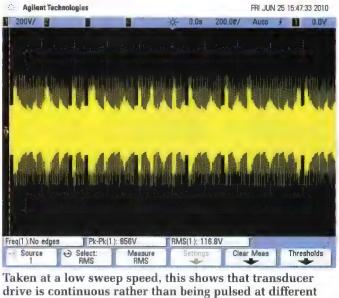
1 22kΩ 1 10kΩ 2 2.2kΩ 1 100Ω 2 10Ω
1 10kΩ linear pot with knob (VR1)

Miscellaneous

Neutral cure silicone sealant suitable for wet areas (eg roof and gutter sealant)
Epoxy resin (eg. J-B Weld)



This scope waveform shows the cleaner in continuous mode whereby it is swept over a small range of frequencies centred around 40kHz.



Taken at a low sweep speed, this shows that transducer drive is continuous rather than being pulsed at different frequencies.

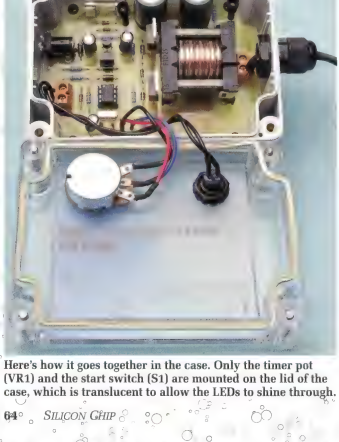
the primary side has seven pins and the secondary side has six pins.

That completes the PC board assembly.

The case

Cut the potentiometer shaft so that it is 12mm long or to suit the knob used. The front panel label shows the positioning for the start switch and the potentiometer that mount onto the lid. The front panel label can be downloaded from our website as a .PDF file.

You can print it out onto paper or clear overhead projector film. Mark out and drill the holes in the clear lid.



Here's how it goes together in the case. Only the timer pot (VR1) and the start switch (S1) are mounted on the lid of the case, which is translucent to allow the LEDs to shine through.

The label is mounted inside the lid to protect it. Cut the holes out for the switch and potentiometer using a hobby knife, then attach it to the lid using clear tape, spray adhesive or clear silicone sealant.

The switch and potentiometer are wired as shown using hookup wire and heatshrink tubing over the soldered terminations. The heatshrink tubing helps prevent the wires from breaking off the terminals. Note that the switch is best attached to the lid before connecting the wires to the PC board. The potentiometer can be wired while it is off the lid and attached after wiring.

So that light only shines through the lid where the power and running indications are located on the front panel label, the two LEDs are fitted with short "light tubes".

We used approx. 20mm lengths of 5mm tubing and temporarily inserted the DC plug from the 12V plugpack into one end of the tubing to about 4mm inside the tube end. This acted as a heat shrink tubing former. Then the other end of the heat shrink tube was placed over the LED and the tubing was shrunk down using a heat gun. The DC plug was removed after the tubing had cooled leaving a round tube shape above the LED. Without the DC plug inserted first, the tube would shrink up too tightly.

Holes are required in the ends of the box for the power connector and for the cable gland for the lead to the ultrasonic transducer. The power connector hole is 8mm in diameter and is located 31mm to the right of the outside left box edge and 16mm up from the outside base of the box.

The 12mm cable gland hole is located on the opposite end of the box, 27mm up from the base edge and in the centre.

The 12V 2.5A plugpack is supplied with several connectors. Choose the concentric connector that fits into the DC socket. Attach this connector to the DC plugpack lead with the + marking on the connector plug to the + marking on the connector socket. With the plug removed from the DC socket check that there is 12V at the connector plug and that the centre hole is the + terminal and the outside is the – terminal.

If polarity is not correct, check the orientation of the connector connection to the plugpack lead.

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The transducer "potted" into some PVC plumbing fittings with silicone sealant, ready for attachment to a suitable cleaning tank. Make sure the terminals are covered!

Plug the DC connector into the DC socket and check that there is 5V between pins 1 and 8 on the IC1 socket. Pin 1 should be +5 compared to pin 8. The voltage may vary from exactly 5V and could be any voltage between 4.85 and 5.15V. Typically the voltage will be closer to 5V.

If the voltage is correct, power can be switched off and IC1 inserted taking care to match its notch with the notch in the socket.

Piezoelectric transducer

Note that the voltage across the terminals of the piezoelectric transducer can be up to 900V peak to peak or so (see scope waveforms) – so avoid contact with these terminals when the driver is running.

Use 2-core sheathed mains cord for wiring to the ultrasonic transducer. The wire terminates onto solder lugs and is covered with heat shrink tubing. The terminals are secured to the ultrasonic transducer terminals using an M4 screw, star washer and M4 nut for each. These terminals on the transducer are exposed and need to be protected within a housing to prevent contact.

A suitable housing is made up using 65mm PVC DWV (Drain, Waste and Vent) fittings. As mentioned, the Ultrasonic transducer can be directly inserted into a bath if the transducer is raised sufficiently so that the lower 5mm of the transducer is immersed in the fluid. A typical housing is shown in the photo on page 58.

Alternatively, the transducer can be secured to the outside of a "bath" using epoxy resin as shown above. We used an end cap and a 40mm length of pipe to house the transducer.

Keeping the plumbing theme going(!), here's our cleaning tank: an old cistern, with holes suitably plugged, with the smooth face of the transducer glued directly to the outside of the case using J-B Weld. You could use just about any metal or plastic leakproof container as a tank. Ours works a treat!

The wire entry is via a cord grip grommet that secures to the end cap so that the wires cannot be pulled out to leave exposed live wires. Shape the cord grip grommet hole so that it is captured correctly within the end cap and holds the wire securely. The twin core sheathed cable we used was not held securely with the cord grip grommet and so we looped the cable in an 'S' shape so that three layers of the wire are captured in the grommet.

The transducer should be mounted within the enclosure using neutral cure silicone sealant (such as roof and gutter sealant). The lower section of the transducer should be kept free from the sealant. This is so that the transducer can more effectively couple to the liquid in the bath either directly or when secured to the outside of the bath with epoxy resin. Make sure the electrical terminals are covered with silicone to provide insulation and prevent accidental contact.

To make connection between the ultrasonic driver and the PC board, it's easiest before the board is mounted in the box. Ensure power is off and pass the 2-core sheathed mains cord through the cable gland locking nut, the cable gland itself (which means it goes through the box) and carefully connect the two wires to the output terminals. Make absolutely sure there are no strands of copper wire emerging from the terminals – and most importantly short-

RESISTOR COLOUR CODES

	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	22kΩ	red red orange brown	red red black red brown
❑	1	10kΩ	brown black orange brown	brown black black red brown
❑	2	2.2kΩ	red red red brown	red red black brown brown
❑	1	100Ω	brown black brown brown	brown black black black brown
❑	2	10Ω	brown black black brown	brown black black gold brown

Capacitor Codes

Value	µF Value	IEC Code	EIA Code
100nF	0.1µF	100n	104
22pF	NA	22p	22

ing between the terminals.

Install the Ultrasonic Cleaner PC board into the box and secure in place with the four M3 screws. Pull the 2-core mains cable through the cable gland so it has a just little slack inside the box and secure the cable with the locking nut on the gland.

The bath

When the Ultrasonic transducer is directly inserted into the bath, the bath can be made of almost any suitable material ranging from plastics through to glass and metal.

For external attachment of the Ultrasonic transducer, the bath can be made from stainless steel, aluminium or plastic that couples the ultrasonic vibration through into the fluid. Thinner materials couple the ultrasonics with less loss. Ideally the bath should have a flat side or base where the transducer can be attached. The material also needs to be compatible with the epoxy resin used to glue the transducer to the bath. Metals are the most compatible material.

Larger sized baths with more liquid will have a lesser cleaning effect than smaller containers with less fluid. A 200mm diameter or smaller cylindrical container or a similar sized rectangular bath size could be used with up to one litre of fluid in the bath. This is ideal for the ultrasonic sensor and driver. Alternatively a stainless steel kitchen sink can be pressed into service.

The fluid used in the bath can be water with a few drops of detergent as a wetting agent. Other fluids that can be used include methylated spirits. Cleaning effectiveness is greatly enhanced when the fluid is warmed.

Normal operation of the Ultrasonic Cleaner is where the frequency is cycled over the 19kHz to 42kHz range. Firstly, set the timer as shown on the front panel label for up to 10m. Pressing the start switch begins the cleaning cycle. The cleaning can be stopped at any time by rotating the timer potentiometer fully anticlockwise or switching off power. Power is indicated with an LED, while cleaning operation is shown with a second LED. The running operation will show the LED with a small amount of flickering.

For stubborn hard to clean components, you can set the driver mode to the alternative setting. To do this switch off power and wait until the power LED is out. Then press the start switch and apply power. Hold the switch for a couple of seconds and then release the switch. This sets the alternative driver cycle that centres about 40kHz. Note that it is recommended that this alternative mode be only used intermittently and for less than a few minutes since the Mosfet and transformer run hot during this cycle.

To return to the normal mode, firstly switch off power and wait again until the power LED is out. Then press the start switch and apply power. Hold the switch for a couple of seconds and then release the switch. This will return the cleaner to the normal driver cycle.

So how can you identify which cycle is running? The setting when the Ultrasonic Cleaner is first built is the normal cycle. For this cycle, the running LED will flicker on and off and the transducer will emit its own distinctive audible sound. And yes the transducer is ultrasonic but some sound is heard as the transducer is swept over frequency. Sub harmonics and the frequency modulation are audible. For the alternative cycle, the running LED will be virtually flicker-free and the audible sound will differ from the normal cycle mode. SC

Why is Ultrasonic Cleaning effective?

A component that has contaminants on its outside layer can be cleaned by physical removal of the contaminants or by dissolving the contaminant. Which process works depends upon the contaminant.

For example solids are more effectively removed by physical means whereas oils are better removed by dissolving in solution. Sometimes a combination of physical dislodging and chemical dissolving of contaminants is necessary to remove various combinations of contaminants.

Ultrasonic energy improves both the dissolving and physical removal of the contaminant. Where ultrasonics is used as an aid in the dissolving process can be seen in the Figures from Fig.6 to Fig.8. Fig.6 shows a component that has a contaminant adhered to its surface that is placed in a cleaning fluid solution.

As the cleaning fluid begins to dissolve the contaminant, it becomes saturated with the contaminant and so it loses its effectiveness in cleaning. This is seen in Fig.7.

However, as shown in Fig.8, when ultrasonic excitation is included in the cleaning process, the saturated cleaning fluid is displaced allowing fresh cleaning fluid to come into contact with the contaminant to dissolve it. As shown, the component surface is a flat edge that could be cleaned with a mechanical method other than ultrasonics. For irregular and internal surfaces on a component, ultrasonics is very effective because it can reach where other mechanical removal means is impossible to gain access to the contaminated surfaces.

Where the contaminant comprises solids that are not dissolved by the cleaning fluid, ultrasonics also aids in removing these particles from the component surface. However, the cleaning fluid must wet the particles so that this fluid can then carry the particle away from the component surface.

The ultrasonics assists in the removal of the particle from the component and in the motion of the cleaning fluid as it carries the contaminant away from the component site. It is also possible that ultrasonics may increase the rate of chemical action in the dissolving of contaminants.

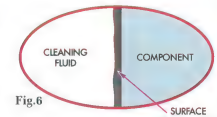


Fig.6

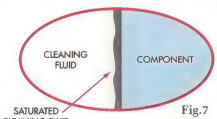


Fig.7

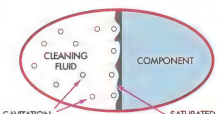
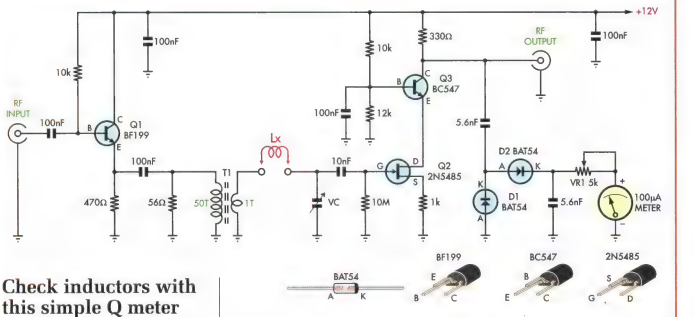


Fig.8

CIRCUIT NOTEBOOK

Interesting circuit ideas which we have checked but not built and tested. Contributions from readers are welcome and will be paid for at standard rates.



Check inductors with this simple Q meter

While LCR meters are readily available at reasonable cost, they do not measure the Q of an inductor. This circuit enables you to measure the Q of inductors with the aid of an RF signal generator.

A capacitor is connected in parallel with the inductor to form a tuned circuit. By varying the frequency, you can measure the resonance frequency of the tuned circuit and its -3dB bandwidth. The Q is then the resonance frequency divided by the -3dB bandwidth.

Transistor Q1 is an emitter follower acting as input buffer to drive RF transformer T1. The secondary winding of T1 then drives the parallel tuned circuit formed by the inductor under test (Lx), T1's secondary and tuning capacitor V_C.

The tuned circuit so formed is buffered by JFET Q2 and transistor Q3 which form a cascode stage with about 3dB of gain. The JFET provides a high impedance so that the loading of the tuned circuit is minimal (note: an MPF102 can be substituted if you cannot obtain a 2N5485).

The RF output from Q2's collector can be monitored by an oscilloscope to easily find the point of resonance and read the frequency. Alternatively, the RF output can be read by an external frequency meter.

Diodes D1 & D2 and the 5.6nF capacitors form a voltage doubler rectifier to drive a 100µA DC meter so that the resonance can be found (in the absence of an oscilloscope).

Trimpot VR1 provides a sensitivity adjustment for the meter.

Transformer T1 is wound on a 12mm diameter ferrite toroid core. The primary winding consists of 50 turns of 0.2mm diameter enamelled copper wire, while the secondary is a single turn consisting of a strip of brass 0.5mm thick and 2.5mm wide bent into a horseshoe shape and threaded through the centre of the toroid. V_C is a small AM tuning capacitor with both gangs connected in parallel.

To measure Q, the output of the RF signal generator should be around 0.5V peak. Adjust the frequency until the meter's reading peaks, then adjust VR1 so that the meter reads full scale (100µA). Read the resonance frequency F_0 from the frequency scale of the signal generator or better still, the reading on a frequency meter.

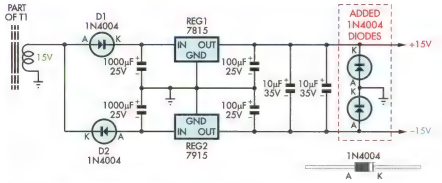
Next, increase the signal frequency until the meter reads 70µA and note this frequency as F_2. That done, reduce the frequency on the signal generator below the resonance frequency until the meter again reads 70µA and note this frequency as F_1. The Q can now be calculated as:

$$Q = F_0/(F_2 - F_1)$$

While using a variable tuning capacitor will enable a wider range of inductors to be tested, the main advantage is estimating the distributed capacitance of the inductor as well. To do this, you have to calibrate the tuning scale with a capacitance meter, by measuring the capacitance across the tuning capacitor with no inductor connected. This is done with the unit switched off. Marking off increments of 20pF should be sufficient.

Set the tuning capacitor to say ¼ of its maximum value and note this value as C1. Adjust the RF signal generator frequency so that the inductor under test is at resonance and note this frequency as F_0. Now set the RF generator frequency to half F_0, adjust the tuning capacitor until resonance and note this capacitance as C_2. The distributed capacitance of the inductor is $(C_2 - 4C_1)/3$.

Alex Sum,
Eastwood, NSW. ($45)



Adding protection diodes to positive/negative regulator circuits

With any regulated split power supply (ie, one with positive and negative voltage outputs), it's good practice to add diodes between both outputs and ground, orientated so that they are reverse-biased during normal operation.

These diodes are necessary because without them, the positive output can be pulled below ground by the negative regulator (or vice versa) via the load or output capacitors. Depending on the specific regulators used, this can result in a "latch-up" condition whereby one regulator cannot start, so only one output voltage rail is present.

Typically, this will mean that the negative regulated output is present but the positive rail is not operative.

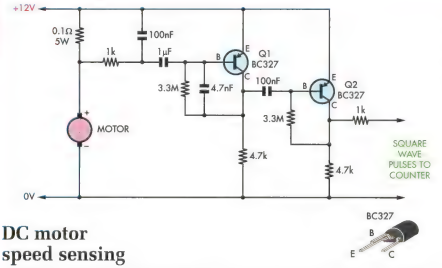
The above diagram shows the Ultra-LD Preamplifier power supply (SILICON CHIP, November 2001-January 2002) with these diodes added, to fix this oversight in the original design. The original circuit works with National Semiconductor LM-7815 and LM7915 regulators but problems can occur if an ST Micro or other branded 7815 is used. The ST Micro regulator will not start if its output is pulled below -0.7V.

This can easily happen when the unregulated DC inputs come from half-wave rectifiers (as in the case of the Ultra-LD preamp). Depending on when power is applied, one regulator can turn on fully before the other one is properly powered up from its DC input. When that happens, the "victim" regulator, if we can call it that, has its output pulled below (or above) ground and this brings the short-circuit protection into operation.

The diodes prevent this latch-up condition by conducting and preventing the "victim" output from going any more than 0.7V (one diode drop) beyond ground. They can be soldered to the rear of the Ultra-LD preamplifier board. If this board has already been installed, they can be carefully added without removing it from the case.

Note, however that they are not really necessary unless the amplifier sometimes fails to operate when switched on.

Nicholas Vinen,
SILICON CHIP.



DC motor speed sensing

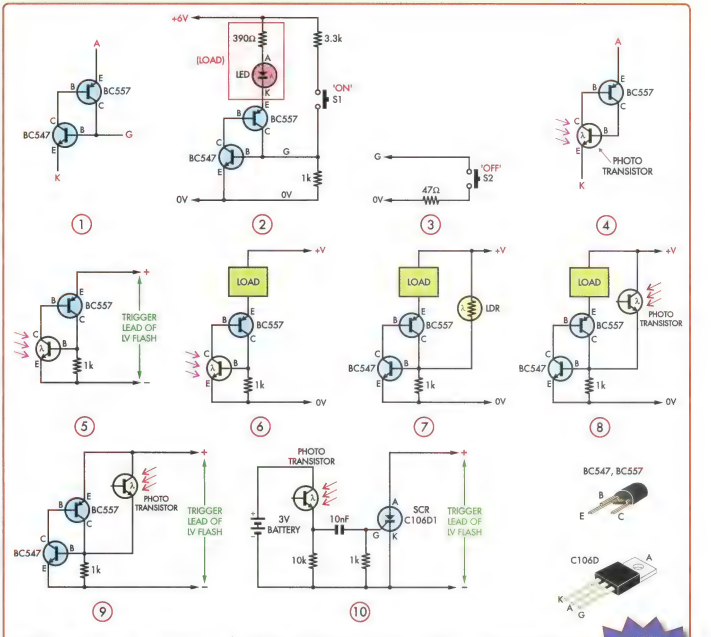
All DC motors with commutators have a current which fluctuates due to the intermittent contact of the brushes and commutator segments. This fluctuation is greater for motors with a small number of segments and smaller for commutators with a larger number of segments. Either way, the frequency of the current fluctuation is directly proportional to the motor speed. This circuit monitors the AC component of the motor current which is sensed by a 0.1Ω 5W resistor.

The circuit consists of two common-emitter gain stages to amplify the AC signal from the sensing resistor to the point where it can be read by a frequency counter. Both transistor stages are AC-coupled so that they are not affected by the DC voltage across the sensing resistor.

This circuit was used to sense the speed of a standard 12V windscreen wiper motor. The value and power rating of the sensing resistor may need to be altered to suit higher or lower powered motors. Note also that the circuit may not work well if the motor is powered from a switchmode power supply which has significant hash superimposed on its output.

If the output signal is to be monitored by a microprocessor, it should be clipped to a safe level by diodes or a suitable zener diode.

Gerard La Rooy,
Christchurch, NZ. ($40)



SCR circuits based on discrete transistors

While high-power SCRs are relatively easy to obtain, low power and sensitive gate SCRs can now be quite difficult to find. The same comment applies to opto SCRs and gate-turn off SCRs. However, it is possible to obtain SCR functions by interconnecting low power NPN and PNP transistors as shown in Fig.1.

This configuration is shown in a conventional SCR circuit which has standard gate triggering. This can also provide a gate turn-off function with the addition of the switch shown in Fig.3. Gate turn-off is normally only available in some high power SCRs.

By substituting a phototransistor for the NPN device, you can produce a light activated SCR or LASCR (Fig.4) which are now unavailable. When the LASCR is illuminated, it turns on and will stay on.

It could be used in the flash trigger circuit shown in Fig.5, provided that the flash trigger is a low voltage arrangement (eg, 6V).

Other examples of light-triggered SCR circuits are shown in the remaining circuits, with the example of Fig.10 being suitable where the flash trigger is a high voltage.

The maximum "SCR" current is limited by the transistor base-emitter rating, in these cases to 100mA.

A. J. Lowe,
Bardon, Qld.

A. J. Lowe is this month's winner of a Peak Atlas Test Instrument

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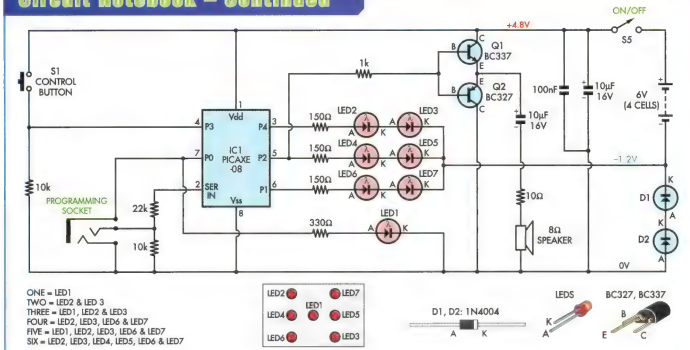

ONE = LED1
TWO = LED2 & LED 3
THREE = LED1, LED2 & LED3
FOUR = LED2, LED3, LED4 & LED7
FIVE = LED1, LED2, LED3, LED4 & LED7
SIX = LED2, LED3, LED4, LED5, LED6 & LED7

Playing dice games with a PICAXE08M

This circuit enables you to play three separate dice games. It's quite straightforward and is based on a PICAXE08M microprocessor and its associated programming socket, a single pushbutton switch, seven LEDs arranged in a matrix to provide a dice display, a speaker, a power switch and a 6V battery.

Diodes D1 & D2 are included to reduce the voltage on the PICAXE to 4.8V while still allowing the series-connected LEDs to run from the full 6V supply. The voltage drop across the LEDs will prevent the higher voltage reaching the PICAXE output pins and causing damage.

A table on the circuit diagram indicates which LEDs are driven for each dice number. Up to three PICAXE outputs are needed to display the larger numbers.

There are three separate dice games in the program listing: Standard Dice, Musical Dice and Rolling Dice. Each game features sound and music and also the ability for the dice to automatically roll. You must choose a game each time the power is switched on. The centre will show one LED, then two LEDs, then three LEDs and the sequence will be repeated. You select the game to be played by pressing the button to match the number of LEDs turned on to the number of the game required.

Standard Dice displays a random number between one and six each time you press the button. The only sound in this game is a beep each time the button is pressed.

Musical Dice is the same as above except that each time a six is thrown, you hear music playing. After the music (from the Batman Movie) is finished playing, the program will pause and the display will be blanked and will wait for the pushbutton to be pressed to restart the game. Musical dice can be used in a "pass the parcel style" party game where the parcel is passed from child to child – with each child pressing the pushbutton before passing the parcel on until the music is heard and the child holding the parcel wins a small gift.

Rolling Dice adds more variation in that the dice throws are now automatic and do not depend on the pushbutton being pressed; the pushbutton is only needed after the music stops to restart the game.

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Random playback trigger for the Voice Recorder

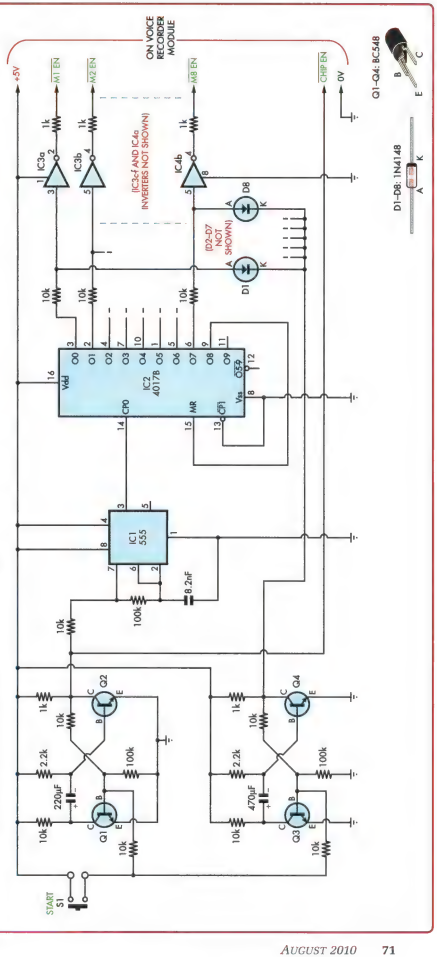
This circuit will provide for random playback of one of eight messages from the SILICON CHIP Voice Recorder (December 2007) each time a pushbutton is pressed. It comprises two monostable pulse generators, based on transistor pairs Q1 & Q2 and Q3 & Q4. Pressing the pushbutton initiates both monostables which each produce a single high output pulse.

The monostable based on Q1 & Q2 produces a 300ms pulse which enables an oscillator based on 555 timer IC1, running at about 1.2kHz. This clocks counter IC2. At the same time, the 300ms pulse is fed to the enable input on the Voice Recorder.

IC2 counts for the duration of the clock input and one of the eight outputs will then go high and stay that way until the clock is retriggered. This high is buffered by the associated section of a 4049 quad inverter (IC3 & IC4) and the resulting low signal is used to trigger the appropriate input on the Voice Recorder.

The second monostable (Q3 & Q4) is configured for a high pulse of about 800ms and is connected to the eight outputs of IC2 via D1-D8. During the monostable pulse, both ends of the diodes are high and the Voice Recorder can be activated. About 500ms after the count stops, the monostable output returns to low and takes all the outputs of the 4017 low. The inputs to the Voice Recorder thus go high again and playback does not repeat until it is re-triggered.

Nicholas Dunand,
Ascot Vale, Vic. ($40)



The games are based on a random number generator working within a range of 0-255. This is divided into six bands of approximately 42 numbers and each band is assigned one number on the dice face. Another variation is a Ticking Bomb Game whereby only three LEDs are employed and it ticks once a second. When the bomb goes off there is no explosion but it plays the Death March.

The PICAXE "sound" command is used for the pushbutton beeps and the "tune" command for the music. All the sounds and tunes can be changed and at the end of the listing are six additional short tunes that may be used to provide variation.

Note that the speaker output from IC1 at P2 also drives LED4 & LED5 and these will flash when any sound is played.

Ian Robertson,
Engadine, NSW. ($50)

Note: the two program listings *3dicegames_pgm.bas* and *tickingbomb_pgm.bas* can be downloaded from the SILICON CHIP website.

HAMEG HMF2550 50MHz Arbitrary Function Generator

This signal generator can deliver a 14-bit arbitrary waveform at 250 megasamples per second, a sine or square wave up to 50MHz or a triangle wave up to 10MHz. It can modulate the amplitude, frequency or phase by another generated or external waveform. It also does Pulse Width Modulation (PWM), Frequency Shift Keying (FSK) and more.

Because the Hameg HMF2550 is an arbitrary function generator, it can produce practically any repetitive waveform shape with up to 256,000 distinct points. Generating sine, square and triangle waves is easy since they are pre-programmed and accessible via dedicated front panel buttons. The square wave has an adjustable duty cycle while the triangle wave has adjustable symmetry.

It has several other wave shapes stored in ROM such as sawtooth, noise, cardinal sine ("sampling function" or "sinc") and exponential sawtooth. User-defined waveforms can be stored in RAM or on a USB flash memory drive. They can be entered manually via the front panel (a tedious process), saved from a computer or captured from a Hameg oscilloscope.

It also has a pulse output mode which is ideal for synthesising signals compatible with digital logic inputs.

The unit

The HMF2550 is housed in a slim, attractive case about two rack units high. The control panel is uncluttered despite the many pushbuttons, some of which illuminate to show the current mode. The display is a 9cm colour TFT

Review by Nicholas Vinen

LCD which is small but also bright and sharp.

Three BNC connectors are mounted on the front panel – the signal output, the trigger input and the trigger output. The trigger output is useful for synchronising an oscilloscope or another signal generator. There is also a USB connector for connection of flash drives containing custom waveforms.

There are four more BNC sockets on the rear panel – the external modulation input, the ramp output (more on this later), the 10MHz frequency reference output and a frequency reference input for synchronisation. There is also a second USB port for connection to a computer along with an RS-232 serial port and the mains power socket.

Accessories supplied include the power cord, user manual and software CD.

User interface

In general the HMF2550 is easy to use. Its major modes are directly accessible via dedicated, illuminated buttons. The TFT display shows the the current generator settings as well as a rough depiction of the output waveform shape.

The Sine, Square, Triangle, Pulse and Arbitrary buttons select the main output mode with a single press. Another three buttons enable Modulation, Sweep or Burst (one at a time).

Central to the front panel is the sixteen-button keypad used to enter values (frequencies, voltages, times, etc). Value entry is made simple by the four unit scale buttons to the right of the digits. For example, to enter a frequency, you type a number and then press either "MHz", "kHz", "Hz" or "mHz". This is intuitive as numbers can be entered in whatever scale you prefer.

These scale buttons are labelled with other units too. So if a voltage is being entered, they become "V", "mV", "dBm" or "%". For time entry they become "ns", "µs", "ms" or "s".

Alternatively, these values can all be varied by rotating the knob, although that is really only useful for small adjustments. Generally the knob (and the four arrows arranged around it) is used to select the field to be manipulated.

The three quick access buttons above the output BNC socket are a nice touch, allowing the user to toggle the output on or off, enable or disable the output offset voltage or invert the output signal with a single press.

The remainder of this unit's functions are accessed via the menu button and five "soft" buttons arranged alongside the display, whose function changes depending upon the current mode. Much of the time they are used as short cuts to select a field to be manipulated (frequency, amplitude, modulation type etc).

Unfortunately, some of the functions do not respond instantly to button presses. There can be delays of half a second or more when switching modes but simple functions such as changing the frequency or amplitude via the keypad are quite fast so it is generally not a major issue.

Features

The first extended mode is Modulation, where a second waveform can be used to modulate the signal. This waveform can be another arbitrary waveform or supplied via the analog modulation input. The supported modes are amplitude modulation (AM), frequency modulation (FM), phase modulation (PM), frequency shift keying (FSK) and pulse width modulation (PWM).

In each case, the amount of modulation can be adjusted.

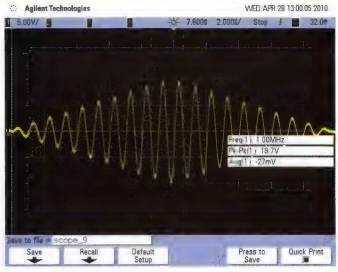


Fig.1: the amplitude modulation feature in action. The 20V peak-peak 1MHz sine wave is being modulated by a lower frequency triangle wave over 100% of the amplitude range.

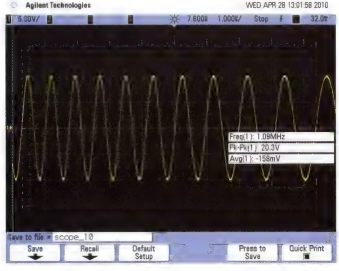


Fig.2: here the generator has the same settings as in Fig.1 but using frequency modulation, with a large amount of frequency deviation to make it more obvious.

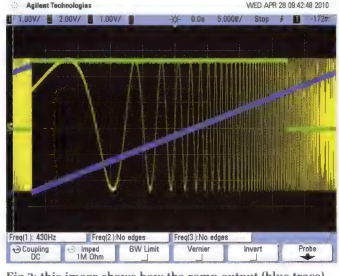


Fig.3: this image shows how the ramp output (blue trace) and trigger output (green trace) operate in sweep mode. The sweep is a 20Hz-20kHz sine wave at full amplitude.

The rear panel has the USB and RS-232 interfaces along with modulation input, sweep output and 10MHz reference input and output.

In AM mode it is specified as a percentage of the amplitude, in FM mode the maximum frequency deviation, in PM mode the maximum phase deviation, in FSK the frequency hop size and in PWM mode the duty cycle percentage variation.

The second extended mode is Sweep, where the signal frequency smoothly changes between the start and stop frequency with either linear or logarithmic timing. Simultaneously the ramp output sweeps linearly from 0V to 5V (see fig.3). This can be captured by another instrument and used to plot the frequency response of the device under test.

The third extended mode is Burst, which repeats the waveform a specified number of times in a given time interval (see fig.4). Alternatively, the signal can be "gated" by an external source; ie, whenever the gating signal is low output is disabled and when it is high the output is enabled.

The Pulse waveform functions differ from the other modes. When Pulse is selected, the output level varies between 0V and the specified voltage (say, 5V). The rise and fall times can be specified, as can the duty cycle. In this mode, only Pulse Width Modulation is possible (see fig.8). PWM can not be used in any other mode.

As with other modulation modes, an internal or external signal can be used. The result is a pulse train at the specified frequency and average duty cycle, with the duty cycle varying with the modulating waveform level. This could be useful for testing switch-mode power supplies, motor control circuitry, Class D amplifiers or other such devices.

Software

The provided software allows for simple waveforms to be created or edited. It loads and saves CSV (Comma Separated Value) files which contains the co-ordinate data for the waveform. The files can be loaded onto the HMF2550 via the USB or serial interface, or by saving them onto a USB flash memory drive.

However, the most likely source of arbitrary waveforms will be those recorded on an oscilloscope or mathematically generated. Since the HMF2550 accepts data in the common (and easy to create) CSV format, it is possible to convert data from many Digital Storage Oscilloscopes into a format

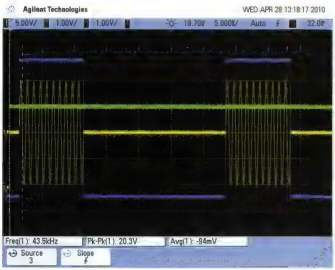


Fig.4: burst mode, configured for 10 repetitions of a 1MHz sine wave every 33µs. The blue trace is the trigger waveform.

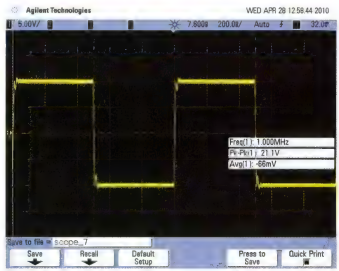


Fig.5: the square wave output at 1MHz. There is some ringing after each transition but the rise and fall times are insignificant at this frequency and there is little rounding.

that the HMF2550 can handle using a spreadsheet program.

The firmware can be upgraded via the USB flash drive interface. It is a good idea to keep the firmware up to date in order to take advantage of all the bug fixes and feature upgrades.

Performance

The sine wave output is visually undistorted from below 1Hz up to 50MHz. The specified harmonic distortion level is <0.04% up to 100kHz.

We made our own sine wave distortion measurements at maximum amplitude (20V peak-to-peak) with a 10Hz-500kHz measurement bandwidth and they are shown in the table below. In summary, our measurements are less than half the maximum specified distortion level. The signal to noise ratio under the same conditions is 92dB (unweighted).

Frequency	THD+N Ratio	Signal Amplitude (peak-to-peak)
100Hz	0.0127%	19.800V
1kHz	0.0128%	19.924V
10kHz	0.0140%	19.896V
100kHz	0.0180%	19.670V

With square wave output, the rise and fall times are below 8ns so it remains fairly rectangular up to 1MHz. Between 1MHz and 10MHz it becomes more trapezoidal, with increasing ringing after the transitions and above 10MHz the signal becomes progressively more sinusoidal.

The maximum triangle wave frequency is 10MHz but distortion is visible at 3MHz and becomes progressively more significant.

The output voltage swing and drive strength are good with up to 20V peak-to-peak into light loads and 10V peak-to-peak into 50Ω loads.

It is possible to improve the frequency accuracy by feeding in an external 10MHz frequency source, but generally this is unnecessary due to the excellent temperature stability (±1ppm from 18°C-28°C) and excellent aging characteristics (±1ppm over one year) of the unit's own reference. In fact the HMF2550 can be used as an accurate 10MHz reference clock source for other instruments.

Conclusion

This is a very flexible signal generator which is easy to set up and use. The wide range of frequencies and amplitudes, and the ease with which user-defined signals can be integrated means that this instrument will meet a wide range of needs. Overall the interface is well designed and intuitive, although if you press the wrong button it can sometimes be confusing to get back to where you were.

The most impressive aspect is the flexibility provided by the modulation options. The pulse and sweep modes are not quite as comprehensive as they could be but in reality this device can perform all the common analog signal generation functions that are needed within its supported frequency range.

The HMF2550 (and 25MHz HMF2525) are available from Rohde & Schwarz Australia. Prices range between approximately $1900 and $2450 depending upon the model and configuration. The standard warranty is one year.

Call (02) 8874 5100 or e-mail Sales.Australia@Rohde-Schwarz.com for more information. SC

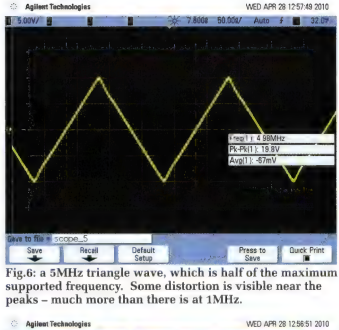


Fig.6: a 5MHz triangle wave, which is half of the maximum supported frequency. Some distortion is visible near the peaks – much more than there is at 1MHz.

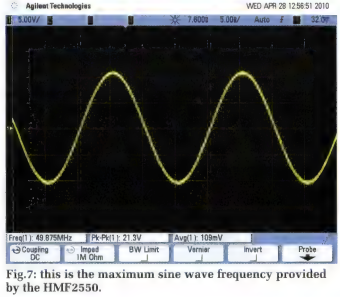


Fig.7: this is the maximum sine wave frequency provided by the HMF2550.

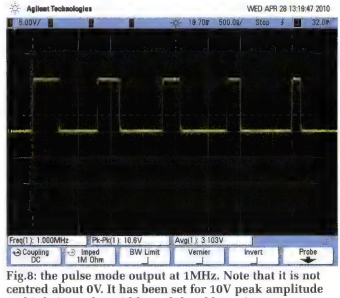


Fig.8: the pulse mode output at 1MHz. Note that it is not centred about 0V. It has been set for 10V peak amplitude and is being pulse-width-modulated by a sine wave.

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A 0152

Combo Wire Stripper & Kwik Crimper

Combines a spring loaded ratchet wire stripper, cutting blade & kwik crimper in a single tool. Saves space in the toolbox! Suits 10-24 AWG cable. Crimps red/blue/yellow kwik connectors.

$22 SAVE 26%

T 1328

Monitor Your Energy Usage!

This wireless home energy monitor can log power usage on up to 3 mains outlets around the house. Includes 1 plug in sensor & base station. Additional sensors P 8138 $24.95. 30m range. Displays usage in kW/h or currency.

$49.95 NEW!

P 8137

Handy 12VDC Power Tester

A must have for CCTV installers & technicians! Checks voltage, voltage drop, battery load, polarity and PTC fuse integrity. Detects AC power for connecting CCTV cameras. Quick croc clip connection!

$34.95 NEW!

Q 3210

Super-Bright Mini Rechargeable Torch

Just 50mm long, this LED torch is always ready to go - charged from your car accessory socket. Great for map reading!

$14.95 NEW!

X 0205

240V Mains Power Anywhere, Anytime!

Efficient "pure sine wave" design delivers pure AC power. Ideal for use in 4WDs, campers, caravans etc. High 3000W surge rating for powering difficult to start loads such as microwaves, computers and televisions. 1000W continuous. 12V input only. Size: 405 x 320 x 125mm.

Latest high efficiency "pure sine wave design!

$729 NEW!

M 8017

Clear The Remote Control Clutter!

Sunwave SRC-7000. Replace up to 64 remote controls with one stylish unit. Every device & control button can be custom labelled. Pre-programmed with codes for most AV equipment, plus it also learns new equipment codes via infra red. Includes rechargeable batteries & charging pod.

$159 SAVE $70

A 0998

Digital TV Panel Antenna

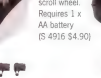
Ideal for home or portable installs in caravans! Provides 25dB of gain for clear digital TV & digital radio reception. Includes power supply & PAL to F connection lead. Indoor or sheltered outdoor installation.

$49.95 NEW!

L 2026

Great Value Computer Accessories...

Desktop Hard Drive Dock



The easy way to move data from one drive to another. Suits 2.5" or 3.5" SATA hard drives. Enables fast 'hot swapping' of drives whilst the PC is on.. A must for IT technicians! USB2.0 or eSATA. Includes power supply.

*Hard drive not included

Fitted with dual USB ports for flash drives!

$46 SAVE 10%

D 5506

Wireless Mouse & Laser Pointer

Mini wireless mouse with inbuilt laser pointer for presentations. Two buttons with scroll wheel. Requires 1 x AA battery (S 4916 $4.90)

$44 SAVE 10%

D 2095

2.4GHz Wireless AV Sender

Great for wireless CCTV! The easy cable-free way to transmit stereo audio & composite video up to 30m. It also relays infra-red allowing you to control equipment remotely. Includes transmitter, receiver and plugpacks.

$59 SAVE 15%

S 9360A

100W Laptop Notebook Power Supply

Ideal replacement for lost/broken laptop supplies. Fitted with dual USB outputs for powering peripherals. Includes 8 tips to suit most laptops. Selectable voltages (15-24VDC), max 6A. Includes mains lead.

$89 SAVE $10

M 8996

USB2.0 4 Port Hub

Connect all your USB peripherals with ease! No power required. Or for high current draw devices, add on an M 8909A plugpack $22.90 & M 9187 tip $1.60.

$15 SAVE 10%

D 2354

$110 pr Hi-Fi 8" 45W Ceiling Speakers

Expand your home audio system with these stylish 8" 2-way coaxial speakers. Aluminium "rust proof" grill allows mounting in sheltered outdoor areas ie: under eaves, alfresco areas. Fast "flip-lock" install tabs.

SAVE 18%

C 2124

Component Video & Digital Audio Cat5 Sender

Send high quality audio and video up to 100m from its source! Uses low cost Cat5/6 UTP cable - no need to run expensive coax. No power required. 1080i max 50m.

$80 pr SAVE 20%

A 3210

Handy USB Mains Travel Adaptor

Great for charging iPods, MP3 players, PDA's, phones & portable game consoles from any 100-240V outlet! Includes Australian, US, UK & European adaptors.

$17 SAVE 14%

M 8890A

Mini HDMI Adaptor

Converts a standard HDMI lead into Mini-HDMI for connection to camcorders, laptops & media players.

$16 RRP $19.95

P 7375

USB Wireless Ethernet Adaptor

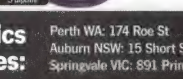
Add wireless networking to your PC or media player instantly. Simply plugs into your USB port to provide 802.11n wireless ethernet up to 300mbps!

$49.95 NEW!

D 0376A

No More Eye Strain!

Illuminated Magnifying Lamp



Identify those tiny components, without straining your eyes. 300mm adjustable gooseneck. Great for stamp and coin collectors, technicians, model makers, seamstresses, jewellers and much more! Spare fluoro: A 0969 $8.50. 240V mains operation.

Includes ultra bright fluoro tube for a crisp view!

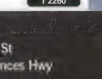
$44 SAVE 12%

A 0966 3 dioptre

$49 SAVE 10%

A 0967 5 dioptre

Precision Digital Pocket Scales



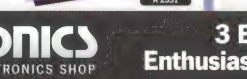
Great for measuring and counting lightweight items. Measures in grams, ounces, troy ounces & pennyweight. 0.1g resolution. 500g max. Includes tough plastic cover.

Excellent accuracy down to 0.1g!

$50 SAVE 22%

T 2260

Super Value Audio Mixer!



Compact & easy to use audio mixer. Fantastic for schools, theatre groups, houses of worship etc.. With 5 channels accepting up to 9 input sources. Also features, 3 band EQ, channel volumes, crossfader and VU meters. 240V operation.

$169 SAVE 15%

A 2551

ALTRONICS
ONE-STOP ELECTRONICS SHOP

3 Electronics Enthusiast Centres:

Perth WA: 174 Roe St
Auburn NSW: 15 Short St
Springvale VIC: 891 Princes Hwy

New Test Equipment For Professionals & Enthusiasts.

Professional Autoranging DMM

Push button controls for easy one handed operation! Multifunction backlit display shows date, time, bar graph & measured reading simultaneously • 3 measurements per second logging for up to 11 min • Resistance, frequency, duty cycle, capacitance, continuity, AC/DC voltage & current ranges • 10A rated • Includes shock proof rubber holster & test leads.

Records up to 11 min of measurements to internal memory!

$69.95 NEW! Q 1071

Combination Insulation Tester & True RMS DMM.

Brings together insulation testing functions & a digital multimeter into one compact handheld unit. A must have for service technicians and eletrical trades people. Internal memory records up to 99 readings. Includes adaptor for measuring SMD capacitors & diodes. Features: • 250 1000V insulation testing • Resistance • Frequency • Capacitance • Temperature • Continuity • 2000MΩ max • Backlit LCD • Cat III 1000V, Cat IV 600V

$249 NEW! Q 1246

Micron® Autoranging DMM.

Simplicity & functionality in one compact test device. Jumbo easy read screen 10A DC current 1Hz-30MHz counter. Includes test leads & temperature probe. Great for students!

$29.95 NEW! Q 1133

Detect Lethal AC Voltages Without Contact

Non-contact AC detector with LED light. Essential for working with AC wiring. Lights up when near any AC source (100-600V @ 50-60Hz). Fits right in your pocket.

$15 SAVE 24% Q 3002

Hot Soldering Savings.

Professional Soldering Station With Digital Readout.

Insist on a professional MICRON for your next soldering iron. This model includes precision digital heating control for the best soldering experience you'll ever have! Other features: • Ceramic heating element • Zero-volt switching • 200-490°C range • Antistatic strap point • Temperature lock • Comfortable slim handle for all day use

$185 SAVE $44 T 2438

2 Year Warranty. Hurry, limited stocks!

45W Temperature Adjustable Soldering Station

An excellent multi purpose soldering iron. Perfect for service technicians, schools, engineers, R&D, production work etc. Japanese ceramic heating element for long life. Adjustable from 250° to 430°C

$79 SAVE $20 T 2443

BONUS BUY: For just $15 extra receive 3 long life iron clad chisel tips, valued at over $37. T 2421 0.4mm, T 2430 0.8mm, T 2432 3.2mm

Micron® 60W Handheld Soldering Iron

GREAT PERFORMER UNDER $20!

Great for enthusiasts & home handymen or as a back up in the toolbox. Equipped with an iron clad, chrome plated tip. Includes safety stand. Ideally used with our T 1310A ($16) or T 1306 ($24.95) bench stands.

$17 SAVE 22% T 2409

Whisk Away Solder Fumes

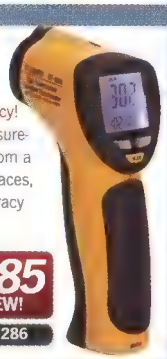
Tired of coughing on soldering fumes when you're working on PC boards? This compact fume extractor whisks away smoke & filters the air at the same time. All metal construction ensures it will last for YEARS!

$79 SAVE $20 T 1295

Professional 'Contact Free' Digital Thermometer

With twin laser guided beam for pin point accuracy! Lightweight, "point and shoot" temperature measurement. Provides accurate temperature readings from a distance. Ideal for measurement in dangerous places, or when equipment is operating. Incredible accuracy from -50°C to 1000°C.

Professional grade specification:
- Ultra-high 30:1 optical resolution
- Fast <150ms response time
- 1% accuracy • 0.1° resolution



$185 NEW! Q 1286

See Inside Walls, Pipes & Conduits...

Hurry, our first shipment sold in just 2 weeks!

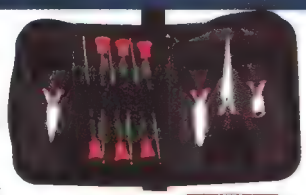
$269 SAVE $30 S 8745

...with this handheld inspection camera & detachable wireless LCD monitor. Great for accessing difficult locations such as wall cavities, ceiling spaces, pipework, industrial machinery & engines. Requires 4xAA batteries for camera (S 4956 pk4 $6.80) Screen fitted with rechargeable battery (charger included).

Stock Up The Tool Box!

19pc Field Technicians Tool Kit

Includes an array of handy tools: • Needle nose pliers • Bent needle nose pliers • Serrated plier/cutter • Side cutters • Bull nose pliers • Flat pliers • Fine tip tweezers • 3 x philips #00, #0, #1 • 3 x flat blade 2.0, 2.5, 3.0 • 6 x star/torx T6, 7, 8, 9, 10, 15



$35 SAVE 12% T 2152

Iroda® Maxi Pro-Torch

Ultra high output design suits heavy duty brazing, silver soldering in plumbing & industrial maintenance. The unique design allows instant heat over long periods without the need for refilling - just latch on a new butane canister when required! Features adjustable regulator and one touch piezo ignition for a reliable startup every time!

$49.95 NEW! T 2497

Don't forget to order gas canisters! T 2455 220gm 4 pack $10.95

12 In 1 Ratchet Driver Kit

Driver bits are stored inside the handle! Ideal for communications gear, phones, laptops. Can be 'locked' as a normal driver if required. Includes: • Extension bar • #000, #00, #0 phillips • 1.5, 2 & 2.5mm flat blade • T4, T6, T7, T8, T10, T15 torx.

$16 SAVE 19% T 2189A

Heavy Duty Automotive Crimper

No more fumbling with poorly designed crimpers! These pro-quality RATCHET action crimpers are easy on the hands, and will ensure connectors have a vice like grip. Suits red, blue and yellow kwik connectors / crimp lugs.

$29 SAVE 25% T 1552A

Both For $15 SAVE 20% T 2342 T 2385

Pick Up Tool & Inspection Mirror

Must haves for the toolbox! Magnetic pickup tool is telescopic.

Test HDMI Leads Instantly

Great for AV system installers! A real time saver on site when troubleshooting installations - tests patch leads or in-wall cabling. LED feedback provides clear indication of continuity & faulty wiring. Requires 9V battery (S 4971 $5.95).

$75 SAVE $14 Q 2030

Test Wiring Polarity & Continuity In A FLASH!

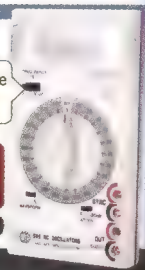
Allows a single user to quickly identify two wires, even when the wire ends are located in different rooms. It makes testing continuity & polarity a breeze, even on long cable runs and wiring harnesses. Supplied with high quality silicon test leads. Includes 9V battery

$30 SAVE 24% Q 2024A

Pocket Audio Signal Generator

Must have test equipment for techs, installers, engineers etc. Generates sine & square waveforms in 46 preset frequencies from 20Hz to 150kHz in two ranges (x1 and x100). Includes test leads & oscilloscope sync output. 2 year warranty. Requires 9V battery (S 4971 $5.95)

Great for on-site servicing!



$79 SAVE 20% Q 1542

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Security For Your Home Or Business!

Protect Your Home & Family Today!

8 Zone Home/Business Alarm System

At last a quality professional alarm system at an affordable price. Install it yourself and save a fortune! Supplied with main unit and keypad; and can be fully installed and programmed by YOU in just hours. Includes comprehensive step-by-step instructions making your installation easy. M 9332A 16V AC plugpack to suit $26.95. Extra keypads (max of 4) S 5269 $59.

With 8 monitoring zones - plus panic alarm function

$169 SAVE $30 — S 5268

Super Loud Siren

High power 110dB piezo driver. 6-15V DC. 99Øx 104Lmm

$20 SAVE 25% — S 6125

4 Core Security Cable

For connecting alarm sensors such as PIR's and detectors. Full 100m rolls only.

$30/roll SAVE 25% — W 2341

PIR Movement Sensors

With 5 year warranty!

A reliable high performance passive infra red detector for security systems. Excellent RFI/EMI immunity. Adjustable pick up range. Size: 100 x 60 x 40mm.

4 For $90 SAVE 16% — S 5314A

$89 NEW! — S 5333

Wall Mount IR Beam Sensor

Ideal for alarm triggering across wide entrances such as rollerdoors/driveways. Water & dust proof. NO/NC trigger output. 40m range. Adjustable beam. 11-18VDC power.

CCTV & Surveillance...

4 Channel Digital Video Recorder With LCD Screen

Features an in-built 7" LCD folding screen for easy playback & monitoring. Provides switching, quad processing and recording functions all in one. Records up to 4 cameras (at 25 frames per second max) to an internal hard drive - available separately. • Direct connection to a PC via USB for recovery of archived recordings • Scheduled recording • Motion detection triggering • Very easy to setup • On screen menu • Includes power supply & software for Win XP/7. • 1TB hard drive to suit D 5513 $139.

$399 SAVE $100 — S 9331

See In The Dark CCD Camera

Upgraded model with vandal resistant weatherprof housing! Excellent low light performance coupled with sharp clarity day time use. Sturdy housing suits indoor and outdoor installs such as under eaves, patio's etc. M 9272A plugpack to suit $17.95.

$109 NEW! — S 9115C

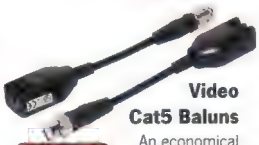
Colour All-Weather Day/Night Camera

Superb build quality. In-built infra red lighting provides plenty of night time coverage. Rugged diecast enclosure can be mounted in exposed outdoor areas. Colour CCD. M 8934A plugpack to suit $26.90.

$119 SAVE $10 — S 9138

Video Cat5 Baluns

An economical and easy to install solution for long cable runs in CCTV installs. Sends colour video up to 300m over Cat5 cable. Sold in pairs.



$25 SAVE 15% — S 9244A

Vandal Resistant Hi-Res Dome Camera

Super tough diecast housing fitted with a high resolution 540 line colour sensor for top quality video. Sloping enclosure for pitch ceilings. 0.1 lux. M 8934A plugpack to suit $26.90.

$170 SAVE $19 — S 9126A

Weatherproof Vehicle Reversing Camera

Measuring just 3cm long, this tiny camera hooks up virtually in-car screen with composite video input. Easily mounts to number plate recess. Mirrored video signal. 12-15VDC input.

$99 SAVE $10 — S 9131

Connect a CCTV System to any PC Monitor.

This compact VGA converter displays a composite signal up to high resolution, 'flicker free', SXGA 1280x1024. Ideal for integrating CCTV into your AV system. BNC input, DE15 VGA output. Requires M 9274A 12VDC plugpack $25.25.

$89 SAVE $20 — S 9290

Micro-Bullet Camera

Compact, weatherproof (IP65) design. Great for monitoring outdoor areas. Superb colour image. M 9272A plugpack to suit $17.95.

$90 SAVE $29 — S 9135A

$5.95ea NEW! — P 0608 Plug, P 0610 Socket

DC Power Jacks With Screw Terminals

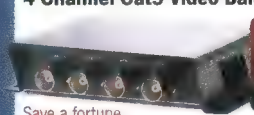
A real time saver for CCTV installs & custom projects. No soldering required! 2.1mm.

1.5m BNC Video Patch Leads

$7ea SAVE 22% — P 6336

Ideal as patch leads from a DVR to monitors or cameras.

4 Channel Cat5 Video Baluns



$90/pr SAVE $29.90 — S 9252

Save a fortune compared to conventional coax cable installs! Sends 4 video signals up to 600m over cat5e cable (300m for colour). BNC connection. No power required! Two required for form a link.

2 For $14 SAVE 25% — S 9178

Deter Thieves & Vandals

...without the expense of real cameras! Looks just like a real camera. 85Ømm.

Coaxial & Fig 8 Combo Cable

2 cable runs in one!

$165/roll SAVE 12% — W 4801 100m

Perfect for wiring up surveillance cameras! Features a RG59 75Ω coax and heavy duty Fig 8 in a single sheath.

Keyless RFID Entry System

$69 SAVE $20 — S 5373

Perfect for access control in home or business. Can be set up to require both RFID & keypad access or RFID only. 3 outputs; 2 x 3A NC/NO for door strike plus alarm triggering. 1A aux relay is provided as a doorbell. 129H x 84W x 41Dmm. Includes keyfob RFID tag. Additional tags $9.15 (S 5376). Up to 500 users!

Home Video Door Intercom

See who's at the door before opening it! A safe and easy way to monitor your front door. Kit includes power supply, hookup cable, indoor base station & camera unit. Coupled with a door strike (available separately) you can even remotely unlatch your front door/gate to let visitors in. Expandable to 2 indoor units & 2 cameras. Black & white. Includes power supply. Extra indoor unit S 9414A $119. Extra camera S 9415A $69

$149 SAVE $30 — S 9413A

Easy Video Door Bell

Hooks up to the composite video input on your TV with the 10m cable included, and provides clear colour video from the infra red camera outside. The wall mount intercom unit lets you speak to visitors without opening the door. Power supply included. Sorry, not available from dealers

$50 SAVE 60% — S 9408

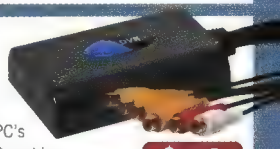
$30 SAVE 24% — A 1015

Replacement Door/Gate Remote Control

Robust replacement for your worn out garage door/gate controller. 260-500MHz UHF operating freq. Battery included. Not suitable for code hopping alarms. Check suitability before making your purchase

Record All Your CCTV Footage To Your PC!

This compact unit records 4 channels of video simultaneously, plus 2 channels of audio to your PC's hard drive. Includes powerful EZ-Cap video management software for viewing footage or setting motion detect & schedule features. 704x576 max recording res. USB2.0 connection. MPEG4.



$49 SAVE 18% — S 9479A

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ONE STOP ELECTRONICS SHOP

No Risk 14 Day Money Back Guarantee

If you are dissatisfied with our goods for any reason, return to our premises within 14 days for a full refund (less transport costs). Returned items must be in NEW condition with all packaging and instructions.

Great Value Project Ideas!

LED Strobe & Tachometer Kit
(SC August '08) Allows you to measure the RPM of fans, rotating shafts, propellers or anything that rotates! Readout displays RPM and frequency simultaneously. 1RPM resolution for excellent accuracy. Adjustable flash period and divider options. Requires 12VDC power.

$79 SAVE $10
K 2510

Measures up to 65,000 RPM

$28.95 NEW KIT!
K 1681

Efficient Car/Motorbike USB Charger Kit
Ultra efficient charging module suitable for permanent connection to your vehicle. Operates at 89% efficiency, with a very low quiescent current when not in use so it won't flatten your battery! 12V input, 5V 525mA output. Ideal for MP3 players, GPS devices & game consoles.

$49.95 NEW KIT!
K 5136

Stereo 2x20W 12V Amplifier Kit
This compact amp module puts out 2x20W RMS into 4Ω and is powered by a 12V source (such as an SLA battery). It could be used by buskers or installed in your caravan or boat. Distortion typically <0.03%. Bass & treble controls.

Measure Ultra-Low Capacitance!
Down to just 0.3pf - far below most 'off the shelf' DMMs!
(SC March '10). Ideal for measuring tiny capacitors or stray capacitance in switches, connectors and wiring. Connects to your DMM via banana plugs. Binding post test points. Requires 9V battery (S 4971 $5.95).

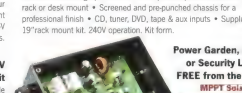
$34.95 NEW KIT!
K 2576

Measure Up To 25kV on a standard DMM!
(SC April '10).
Uses Voltage Probe Kit.
Ideal add on for your multimeter to allow voltage measuring on CRT based scopes, computer monitors, TVs, laser printers, photocopiers etc.
Note: case not included, shortform only.

$28.95 NEW KIT!
K 2559

Silicon Chip 100W Class AB Amplifier $200 OFF! $549 SAVE $200
K 5155

Professional Finish - Sensational Sound!
(SC Nov-Dec '01) Similar spec brand name amplifiers sell for over $2000! Build this kit yourself and save a FORTUNE! Produces 100W RMS per channel with almost unmeasurable low levels of distortion. Features: LED bargraph meters • Gold plated speaker terminals • 19" rack or desk mount • Screened and pre-punched chassis for a professional finish • CD, tuner, DVD, tape & aux inputs • Supplied with 19"rack mount kit. 240V operation. Kit form.



Power Garden, Shed or Security Lights FREE from the Sun!
MPPT Solar LED Lighting Controller Kit
(SC May-Jun '10) When coupled with a 5W solar panel (N 0005A $35) & 3.3Ah battery (S 5063 $15.95) this kit will power 10M of LED lamps for 2.5hrs a day. It accepts input from a remote switch, PIR movement detector or light sensor (for dusk switching). We suggest using with 3 x 3W star LEDs such as Z 0259A $16.95ea.

$89.95 NEW KIT!
K 6028

Loads of fun for the kids!

$69.95 NEW KIT!
K 1107

Robotic Arm Kit
A great introduction to basic robotics and electronics!
Includes five motors allowing base rotation, shoulder, elbow and wrist motion, plus claw for picking up objects (up to 120g). Includes wired controller. Add on the K 1108 USB interface/software kit for full control from your PC ($39.95). No soldering or special tools required!

Stock Up On PCB Prototyping Supplies

Blank PCB
Copper clad fibreglass board. 300 x 300mm single or double sided.

$17 SAVE 14%
H 0755 S/Side

$19 SAVE 13%
H 0756 D/Side

No Fuss PCB Press 'n Peel Film
AS EASY AS 1, 2, 3!
1.Photocopy/laser print
2. Iron onto your PCB
3. Etch your new board.
Pack of 5 A4 size sheets.

$24 SAVE 22%
H 0770

Ferric Chloride PCB Etchant
500ml pre-mixed bottle for easy use. Etches PCB surface in 20 minutes

$10 SAVE 15%
H 0800

Super Discounts On Kemo® Amplifier Modules

Pre-built amp modules for a quick cost effective custom audio solution. All you need to do is connect a power, audio source & speaker! Sealed design for added reliability. See pg182 of the new catalogue for more info.

$32 SAVE 22%
A 0720 12W Mono
No soldering required!

$22 SAVE 15%
A 0702 12W Mono

$15 SAVE 24%
A 0700 3.5W Mono

$22 SAVE 20%
A 0710 3W Stereo

$42 SAVE 22%
A 0705 40W Mono

Sale Ends August 31st 2010

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Cairns	Pentacom	4032 1710
Cloncurry	Access Electronics	4742 2590
Dalby	Camera House	4662 3328
Gold Coast	Prime Electronics	5531 2599
Hervey Bay	Leading Edge Electronics	4124 1490
Innisfail	Leading Edge Electronics	4061 6214
Kingaroy	SB Computers	4160 4800
Longreach	Access Electronics	4658 0500
Maryborough	Leading Edge Electronics	4121 4559
Mossman	Leading Edge Electronics	4098 2200
Rockhampton North	Home Delivered Computers	4928 2555
Rockhampton South	Access Electronics	4922 1358
Toowoomba	Michaelis Electronics	4632 9990
Townsville	SOLEX	4771 4211
Yeppoon	Keppel Electronics	4939 1555
VICTORIA		
Alexandra	Alexandra Air Con & Appliance Centre	5772 1147
Ballan	Radcomp	5368 1761
Beaconsfield	Electronic Connections	9769 9420
Bonalla	North East Electronics	5782 2710
Castlemaine	Top End Technology	5472 1700
Clayton	Rockby Electronics	9562 8559
Cranbourne	Bourne Electronics	5995 2755
Croydon	Truscott's Electronic World	1723 3890
Geelong	Academy TV Australia	5248 2621
Geelong	Music Workshop	5221 5844
Healesville	Amazon DVDs Healesville	5962 2763
Horsham	Leading Edge Electronics	5382 4150
Leongatha	Bair Electronics	5662 3891
Melton	Melton Electronics & Communications	9743 1233
Pakenham	Get Smart HiFi	5941 4886
Preston	Preston Electronics	9484 0191
San Remo	Shoreline Electrical Wholesalers	5678 5361
Swan Hill	Lateral Communications	5032 2322
Warrnambool	Koroit St Electronics	5561 5111
Wodonga	Exact Computers & Home Ent.	6056 5746
NEW SOUTH WALES		
Brookvale	Brookvale Electrical Distributors	9938 4299
Carlingford	Carlingford Music Centre	9873 2333
Cessnock	Leading Edge Electronics	4990 5971
Cober	Cober Electronics	6836 2962
Denilquin	Wired Entertainment	5881 3555
Griffith	Griffith Systems Plus	6964 5933
Gunnedah	Protronics	6742 2110
Lithgow	Leading Edge Electronics	6352 3333
Mudgee	Home & Office Electronics	6372 1822
Nth Richmond	CPT-Candle Power Technologies	4571 4699
Oak Flats	Oak Flats Electronics	4256 6120
Orange	Forotay Electronics	6362 9901
Penrith	Penrith Light and Sound	4733 3333
Port Macquarie	Fettel Communications Pty Ltd	6581 1341
Raymond Terrace	Leading Edge Electronics	4987 4909
Smithfield	Chartronics	9609 7218
Tamworth	Bourke Street Electronics	6766 4664
Taree	Noteledge Systems Pty Ltd	6551 3622
Ulladulla	Leading Edge Electronics	4454 5586
Wagga Wagga	Wagga Car Radio & Hi-Fi Pty Ltd	6925 6111
Wallerawa	Herkes Electrical Supplies	9319 2133
Wetherill Park	Techtron Electronics Pty Ltd	9604 9710
Windang	Mad Electronics	4297 7373
Wyong	CCRV - Pro Disc	4353 1100
SOUTH AUSTRALIA		
Adelaide	Aztronics	8212 6212
Berri	Gardeners Berri Radio & TV	8582 1788
Brighton	Force Electronics	8377 0512
Enfield	Aztronics	8349 6340
Findon	Force Electronics	8347 1188
Kadina	Wellsecured	8821 2300
Renmark	Leading Edge Electronics	8586 6421
Mt Barker	Force Electronics	8391 1133
Milton	Leading Edge Electronics	8682 4911
TASMANIA		
Hobart	Active Electronics	6231 0111
Launceston	Active Electronics	6334 7333
NORTHERN TERRITORY		
Katherine	Leading Edge Electronics	8972 3907
NEW ZEALAND		
Christchurch - Riccarton	Global PC	3 3434475
Christchurch - Shirley	Global PC	3 3543333

Electrolytic reformer ar

Got a bunch of old electrolytic capacitors you'd like to use . . . but don't know if they are any good? Or do you need to re-form the electrolytics in an old valve amplifier or vintage radio set? This Electrolytic Capacitor Reformer and Tester will do the job for you, at any of 11 different standard voltages from 10V to 630V.

Part 1: by JIM ROWE

In addition, it provides the ability to apply the selected test voltage for any of seven periods ranging from 10 seconds to 60 minutes.

Thus you can use it for 'reforming' electrolytic capacitors that have developed high leakage and high impedance due to years of inactivity. As well, it can be used to test the leakage of virtually all capacitors at or near their rated voltage.

Of course, we have to state that not all old electrolytics can be restored – they can't. Some will have very high leakage due to contamination of the can seal or breakdown of the electrolyte and some will have just dried out. In those cases, you cannot do anything to resurrect them but in many cases you will be able to restore and re-use capacitors that have not been used for many years if not decades.

Some very old caps (1960s vintage!) we had took several hours to come good while others, made in more recent years, were good within a few minutes.

Most high voltage (ie, 250V and above) capacitors should be capable of being reformed to the extent that their leakage current drops to around 3mA or less.

The Reformer circuit is designed so that no damage can occur if the capacitor connected to it is short circuit or has very high leakage, or is even connected back-to-front (ie, with reverse polarity). Furthermore, even if the capacitor leakage is very high, the output current is limited so that the maximum dissipation in the capacitor is no more than 2W.

This means that some capacitors might get warm while they are being reformed but none will get so hot that they are in danger of swelling up and "letting the smoke out".

That's a good thing because electrolytic capacitor smoke is particularly foul-smelling! And as any serviceman will tell you, the gunk (electrolyte) inside is particularly nasty if it escapes with the smoke.

The Electrolytic Capacitor Reformer and Tester is housed not in a traditional instrument case or box but in a standard plastic storage organiser case

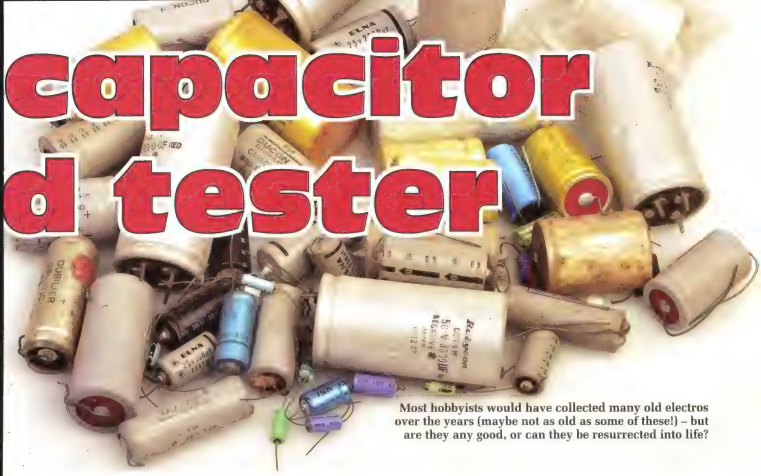
WARNING: SHOCK HAZARD!

Because the voltage source in this instrument can be set to provide quite high DC voltages (up to 630V) and can also supply significant current (tens of milliamps), it does represent a potential hazard in terms of electric shock. We have taken a great deal of care to ensure that this hazard is virtually zero if the instrument is used in the correct way – ie, with the lid closed and secured – even to the extent of quickly discharging any capacitor when the lid is opened.

However, if the safety switching is bypassed, especially when the unit is set to one of the higher test voltages, it is capable of giving you a very nasty 'bite' should you become connected across the test clips or a charged high voltage capacitor. There are some situations where such a shock could potentially be lethal.

Do NOT bypass the safety features included in this design. We don't want to lose any Silicon Chip readers to electrocution.

capacitor d tester



Most hobbyists would have collected many old electros over the years (maybe not as old as some of these!) – but are they any good, or can they be resurrected into life?

which, together with a microswitch interlock, provides a safe compartment for the capacitor when it has high voltage applied.

Another compartment provides handy storage for the switchmode 12V plugpack.

Opening the lid of the case means that no voltage is applied to the capacitor – until the lid is closed – but perhaps even more importantly, opening the lid safely and quickly discharges the capacitor so there is no chance of a nasty electric shock – for you or anyone else. A charged 630V capacitor with its leads exposed is not something to be trifled with!

With the transparent lid closed you can select the test voltage and the period of reform/testing and view the 2-line LCD which shows the capacitor voltage, its leakage current and the time elapsed.

The design

This Electrolytic Capacitor Reformer and Tester is based on the smaller and simpler unit described in the December 2009 issue of SILICON CHIP but with a much bigger selection of test voltages plus the inbuilt test timer which allows the test voltage to be applied for as long as 60 minutes.

We also published an electrolytic capacitor reformer designed by Rodney Champness in "Vintage Radio", October 2006 issue.

However, this new design not only offers higher voltages (the 2006 model only went to 400V), it is fully self contained, is a more elegant design and is **very** much safer to use.

Commercial capacitor leakage current meters/reformers are available but they tend to be fairly expensive (well over $1000) and we don't believe any of them incorporate a safety interlock to avoid the possibility of electric shock.

With ours, you have a choice of eleven different standard test voltages: 10V, 16V, 25V, 35V, 50V, 63V, 100V, 250V, 400V, 450V and 630V. These

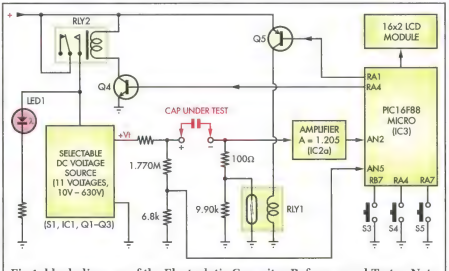


Fig.1: block diagram of the Electrolytic Capacitor Reformer and Tester. Not shown here is the safety interlock microswitch and discharge resistors.

correspond with the rated voltages of most electrolytic capacitors which have been available for the last 30 years or so.

If you have an "oddball" capacitor with a different working voltage, simply select the next voltage down.

(In fact, in the vast majority of cases selecting the next voltage up won't do the capacitor any harm either because most capacitors, especially electrolytics, can stand a short-term higher peak voltage than their working voltage, hence the labelling – eg, 400VW, 500VP).

With any of these test voltages applied to a capacitor you can read its leakage current on the 2-line x 16-character backlit LCD screen, with two automatically selected current ranges: 0-200µA or 0-20mA. As well, you can also read the voltage which appears across the capacitor at any time in the procedure.

Importantly, for reforming capacitors you have the choice of ten test periods: 10 seconds, 30 seconds, 1 minute, 3 minutes, 10 minutes, 30 minutes or 60 minutes.

How it works

Essentially the Reformer's operation is quite straightforward, as you can see from the block diagram of Fig.1. This is broadly very similar to the above-mentioned design in our December 2009 issue.

There are only two functional circuit sections, one being a selectable DC voltage source (on the left) which generates one of 11 different preset test voltages when power is applied to the voltage source (actually a DC-DC converter) via relay RLY2, controlled by the PIC micro (IC3) via transistor Q4. This test voltage is applied to the positive terminal of the capacitor via a protective current limiting resistor and a microswitch, whose purpose we will look at shortly.

The second functional circuit section is on the right in Fig.1 and combines a digital meter which is used to measure any direct current passed by the capacitor under test and the voltage appearing across the capacitor. There is also a digital timer which controls the DC test voltage source via Q4 and RLY2. The PIC micro (IC3) forms the 'brains' of this section.

We use IC3 as a voltmeter to make the current measurement because any current passed by the capacitor flows down to ground via the 100Ω resistor, either alone or with the 9.90kΩ resistor in series. The resistor(s) therefore act as a current shunt and its voltage drop is directly proportional to the current flowing through the capacitor. The meter measures the voltage across the resistor(s) and is arranged to read directly in terms of current.

We also use IC3 to measure the voltage across the capacitor for the duration of the leakage test or reforming period. That way, you can keep track of the leakage current and the voltage at any time. For a good capacitor, the voltage across it will rise while the leakage current steadily reduces.

The reason for relay RLY1 and the

Inside the opened case, showing the main cut-out required. Inset top left is the interlock microswitch which cuts power and bleeds the charge on the capacitor when the lid is opened. And just in case you were wondering – yes, you do have to lay the capacitor down before closing the lid! Note this PC board is an early prototype – several changes have been made to the final version.

9.90kΩ resistor which it effectively switches in series with the 100Ω resistor is that this gives the digital current meter two ranges. This allows it to read leakage currents down to less than 100nA (0.1µA), while also coping with charging and/or leakage currents of up to 20mA or thereabouts. Before the micro begins a test by turning on transistor Q4 and relay RLY2 to apply power to the test voltage source, it first turns on transistor Q5 and relay RLY1 to short out the 9.90kΩ resistor, giving the effective current shunt resistance a value of 100Ω, which gives a 0-20mA range for the capacitor's charging phase.

Only when (and if) the measured current level falls below 200µA does it switch off Q5 and RLY1, increasing the total shunt resistance to 10kΩ and thus providing a 0-200µA range for more accurate measurement of any residual leakage current.

So that's the basic arrangement. Pushbutton switches S3-S5 are used to select the test time period and also to begin a test or end it prematurely. LED1 is used to indicate when RLY2 has applied power to the DC voltage source and therefore when the test voltage is present across the capacitor test terminals.

The reason for the resistor in series with the output from the test voltage source is to limit the maximum current that can be drawn from the source in any circumstances.

This prevents damage to either the voltage source or the digital metering sections in the event of the capacitor under test having an internal short circuit and also protects the 9.90kΩ shunt resistor and the digital voltmeter section from overload when a capacitor (especially one of high value) is initially charging up to one of the higher test voltages.

In the full circuit you'll find that this series resistance has a total value of 10.4kΩ, which was chosen to limit the maximum voltage which can ever appear at the input of the voltmeter's input amplifier (IC2a) to just over 6V, even under short circuit conditions and with the highest test voltage of 630V.

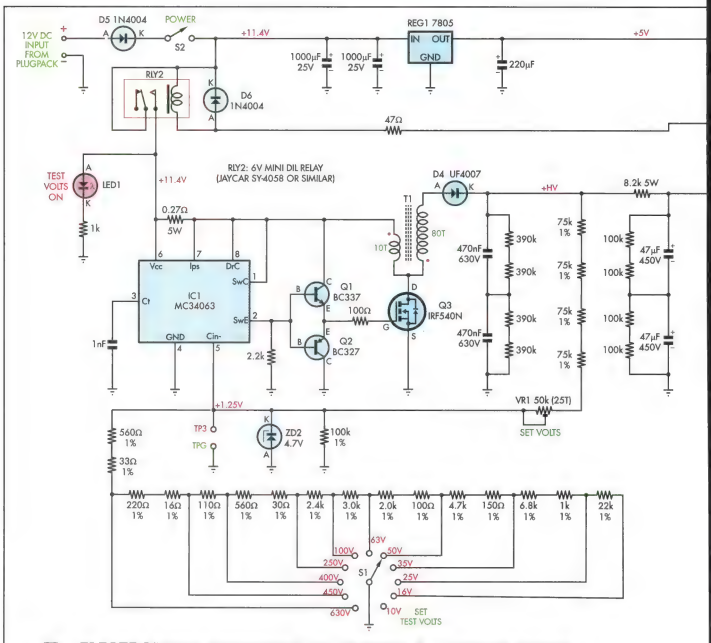
It is also used to limit the current when the instrument is being used for reforming electrolytics.

Circuit description

Now let's have a look at the full circuit of Fig.2. The selectable DC voltage source is again on the left, based around IC1 – an MC34063 DC/DC conversion controller IC.

It used here in a step-up or 'boost' configuration in conjunction with driver transistors Q1 and Q2, switching transistor Q3, autotransformer T1 and fast switching diode D4. We vary the circuit's DC output voltage by varying the ratio of the voltage divider in the converter's feedback loop, connecting from the cathode of D4 back to IC1's pin 5 (where the voltage is compared with an internal 1.25V reference).

The four series-connected 75kΩ resistors, together with trimpot VR1, form the top arm of the feedback divid-



ELECTROLYTIC CAPACITOR RE-FORMER & LEAKAGE METER

er, while the 100kΩ resistor from pin 5 to ground forms the fixed component of the lower arm. These give the voltage source its lowest output voltage of close to 10.5V, which is the converter's output voltage when selector switch S1 is in the '10V' position.

When S1 is switched to any of the other positions additional resistors are connected in parallel with the lower arm of the feedback divider, to increase its division ratio and hence increase the converter's output voltage. For example, when S1 is in the '16V' position, all of the series-connected resistors in the string between the various positions of S1 are in parallel with the 100kΩ resistor, increasing the division ratio to increase the converter's regulated output voltage to 16.25V.

The same kind of change occurs in all of the other positions of S1, producing the various preset output voltages shown. Although the test voltages shown are nominal, if you use the specified 1% tolerance resistors for all of the divider resistors they should all be within ±4% of the nominal values, because the 1.25V reference inside the MC34063 is accurate to within 2%.

IC1 operates only when the 11.4V supply rail is connected to it via relay RLY2, under the control of micro IC3. The converter circuit then operates and generates the desired test voltage across the two 470nF/630V metallised polyester reservoir capacitors, connected in series, with their voltage-sharing resistors in parallel. At the same time LED1 is illuminated, to warn you that the test voltage will be present at the test terminals.

Note that the test voltage present at the top of the feedback divider is not fed directly to the positive test connector, but is first fed through a low-pass RC filter formed by the 8.2kΩ 5W resistor and the series-connected 47µF/450V capacitors (which again have voltage-sharing resistors in parallel).

This filter is to smooth out any rip-

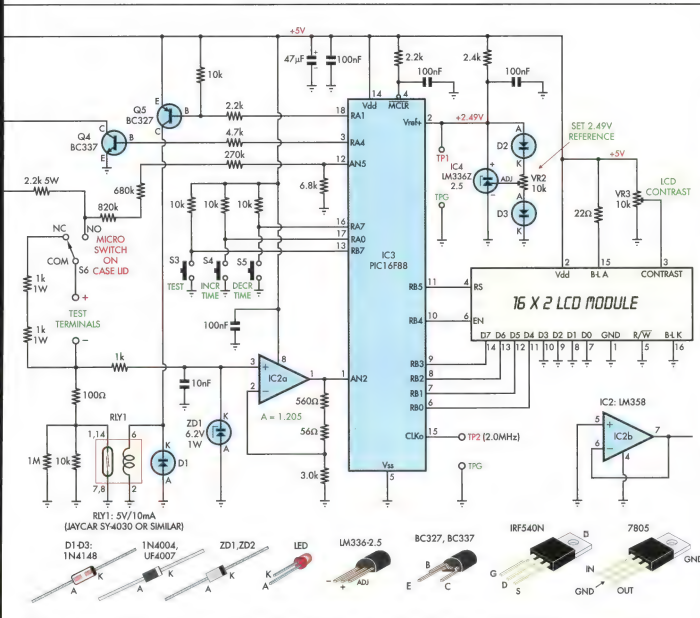


Fig.2: similar to the block diagram, the circuit is divided into two distinct sections – the high voltage generation on the left side and the reforming/reading/metering section on the right, which itself is under the control of a PIC microcontroller. Don't depart from this circuit diagram – a lot of effort has gone into making it safe!

ple present in the output of the voltage source/converter. The filtered test voltage is then made available at the positive test terminal via a 2.2kΩ 5W series resistor, which together with the 8.2kΩ 5W series resistance of the filter forms the protective current limiting resistance shown in Fig.1.

Charged electros can be lethal!

Before the test voltage is fed to the capacitor's positive test connector, it first has to pass through microswitch S6, which is attached to the case so that it switches when the case lid is opened. Normally, (ie with the lid closed) the test voltage is connected but when the lid is opened, the test capacitor's positive terminal is connected to its negative terminal via two 1kΩ, 1W resistors which will discharge even the largest high voltage capacitors normally encountered in less than a second. Two 1W resistors are used to obtain a sufficiently high voltage rating for the highest value test setting.

Of course, very high value lower-voltage capacitors will take much longer to discharge (as much as a few seconds or so) but these are not considered as dangerous to life and limb.

It is important for your safety (and more importantly, the safety of others) that the microswitch is not left out nor bypassed or worse, the circuit built into a case which does not have a hinged lid allowing this form of protection. The circuit is perfectly safe as described.

Wiring external to the PC board (ie, the high voltage wiring) should be made with 250V AC-rated cable. The easiest place to get such cable is from a surplus flexible mains lead. In fact, you might be lucky enough to find that you have some with red and black insulated wires (which are needed for the test capacitor connections) and newer ones with brown and blue insulated wires (ideal for the connections between PC board and microswitch). We wouldn't use the green or green/yellow wiring

Parts List –Electrolytic Reformer & Tester

1 Trojan TJW0510 38cm Storage Organiser (from Bunnings)
1 PC board, code 04108101, 210 x 120mm
1 Front panel label, 320 x 120mm, laminated
1 16x2 LCD module with backlighting (Jaycar QP-5516 or Altronics Z-7013)
1 Mini DIL reed relay, SPST with 5V coil
1 Mini DIL relay, SPDT with 6V coil
1 SPDT 250V 10A microswitch (Jaycar SM-1040 or equivalent)
2 19mm square TO-220 heatsinks
1 Ferrite pot core pair, 26mm OD with bobbin to suit
1 25mm long M3 Nylon screw with nut and flat washer
1 1m length of 0.8mm diameter enamelled copper wire
1 10m length of 0.25mm diameter enamelled copper wire
1 Single pole 12-position rotary switch (S1)
1 Instrument knob, 16mm with grub screw fixing
1 SPDT mini toggle switch, panel mtg (S2)
3 SP Momentary pushbutton switches, panel mtg (S3-5)
186mm long M3 machine screws, pan head
4 25mm long M3 tapped spacers
4 12mm long M3 tapped Nylon spacers (or two - see text)
3 Nylon flat washers (only for QP-5516 module - see text)
2 M3 nuts
1 7x2 length DIL socket strip, OR 16-way length SIL socket strip (see text)
1 7x2 length DIL pin strip, OR 16-way length SIL pin strip (see text)
1 18-pin IC socket
2 8-pin IC sockets
10 PC board terminal pins, 1mm diameter
2 100mm long Nylon cable ties

Semiconductors

1 MC34063 DC/DC converter controller (IC1)
1 LM358 dual op amp (IC2)
1 PIC16F88 microcontroller (IC3, programmed with 0410810A firmware)
1 LM336Z 2.5V reference (IC4)
1 7805 +5V regulator (REG1)
2 BC337 NPN transistor (Q1,Q4)
2 BC327 PNP transistor (Q2,Q5)
1 IRF540N 100V/33A MOSFET (Q3)
1 6.2V zener diode (ZD1)
1 4.7V zener diode (ZD2)
1 5mm red LED (LED1)
3 1N4148 100mA diode (D1,D2,D3)
1 UF4007 ultrafast 1000V/1A diode (D4)
2 1N4004 400V/1A diode (D5,D6)

Capacitors

2 1000µF 25V RB electrolytic
1 220µF 16V RB electrolytic
1 47µF 16V RB electrolytic
2 47µF 450V RB electrolytic
2 470nF 630V metallised polyester
2 100nF MKT metallised polester
2 100nF multilayer monolithic ceramic
1 10nF MKT metallised polyester
1 1nF disc ceramic

Resistors (0.25W 1% metal film unless specified)

1 1MΩ	1 820kΩ	1 680kΩ	4 390kΩ	1 270kΩ
5 100kΩ	4 75kΩ	1 22kΩ	1 8.2kΩ 5W	5 10kΩ
2 6.8kΩ	2 4.7kΩ	2 3.0kΩ	1 2.2kΩ 5W	2 2.4kΩ
3 2.2kΩ	1 2.0kΩ	2 1kΩ 1W	3 1kΩ	3 560Ω
1 220Ω	1 150Ω	1 110Ω	2 100Ω	1 56Ω
1 47Ω	1 33Ω	1 30Ω	1 22Ω	1 16Ω
1 0.27Ω 5W				

1 50kΩ 25T vertical trimpot (VR1)
2 10kΩ mini horizontal trimpot (VR2,VR3)

for ANY purpose except earth wiring.

Some readers may query the use of 250V-rated cable when the highest voltage check is clearly well above this figure – 630V to be precise. The justification is that Australian/New Zealand standard AS/NZ3017 calls for mains power wiring to be tested at 1000V DC so it follows that the insulation of 250V cable must be able to handle this, at least in the short term.

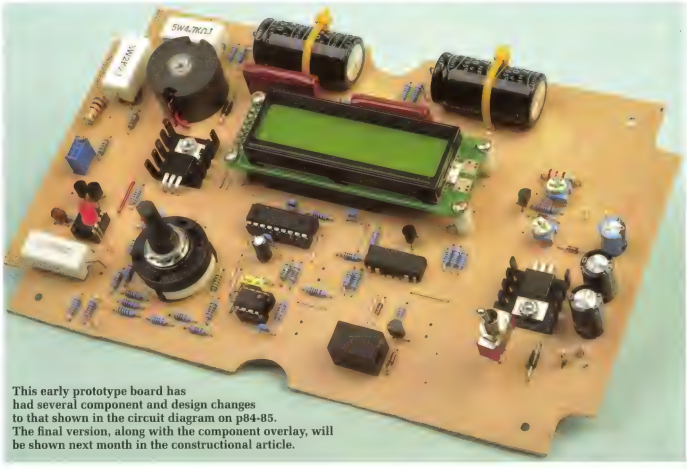
Voltage & current metering

Now let us look at the digital metering and control section, which is virtually all of the circuitry below and to the right of the negative test terminal. The 100Ω resistor and paralleled 1MΩ and 10kΩ resistors connected between the negative test terminal and ground correspond to the current shunts shown in Fig.1, with the contacts of reed relay RLY1 used to change the effective shunt resistance for the meter's two ranges. For the 20mA 'charging phase' range RLY1 is energised via Q5 and connects a short circuit across the parallel 1MΩ/10kΩ combination, making the effective shunt resistance 100Ω. But for the more sensitive 200µA range RLY1 is turned off, opening its contacts and connecting the parallel 1MΩ/10kΩ resistors in series with the 100Ω resistor to produce an effective shunt resistance of 10kΩ.

As you can see the voltage drop across the shunt resistance (as a result of any current passed by the capacitor under test) is passed to the non-inverting input of IC2a, one half of an LM358 dual op amp. And IC2a is configured as a DC amplifier with a voltage gain of 1.205 times, feeding the AN2 analog input of IC3, the PIC16F88 microcontroller which forms the 'heart' of the metering/control section.

IC3 takes its measurements of the amplified current shunt voltage from IC2a by comparing this voltage with a reference voltage of 2.490V fed into pin 2 of IC3. The reference voltage is derived from the regulated +5V supply line via voltage reference IC4, an LM336Z device which is provided with a voltage trim circuit using D2, D3 and VR2. These are used to set its voltage drop to exactly 2.490V, where it displays a near-zero temperature coefficient.

In fact IC3 takes a sequence of 10 measurements at a time and calculates the average of the 10 readings to reduce 'jitter' caused by noise transients.



This early prototype board has had several component and design changes to that shown in the circuit diagram on p84-85. The final version, along with the component overlay, will be shown next month in the constructional article.

It then does mathematical scaling to arrive at the equivalent current readings, which it displays on the 16x2 LCD module.

IC3 also monitors the voltage across the capacitor via a voltage divider feeding its AN5 input, pin 12.

Timer function

As mentioned earlier, pushbutton switches S3-S5 are used to select the test time period to be used and also to begin testing a capacitor. Switch S4 is used to increase the test period time, while S5 is used to decrease it. Then when the user has set S1 for the correct test voltage and has selected the test time period using S4 and S5, testing is begun by pressing S3.

IC3 then turns on Q5 and RLY1 to set the metering circuit for the 10mA range, after which it turns on Q4 and RLY2 to feed power to the test voltage converter (and LED1). It also starts a software timer to control how long the test voltage is to be applied.

While the test is being carried out, the metering section takes voltage and current readings and displays these on the LCD module, changing down to the 0-200µA range automatically if the measurements drop below 0.2mA. Then when the selected test time period ends or the user presses S3 again to end the test prematurely, IC3 switches off the test voltage source. The voltage and current measurements continue however, so you can monitor the current decay as the test voltage drops to zero.

Zener diode ZD1 is included in the metering circuit to protect the pin 3 input of IC2a from damage due to accidental application of a negative or high positive voltage to the negative test terminal (from a previously charged capacitor, for example). On the other hand diode D1 is included to protect transistor Q5 from damage due to any back EMF 'spike' from the coil of RLY1 when it is de-energised.

Trimpot VR3 allows the contrast of the LCD module to be adjusted for optimum visibility. The 22Ω resistor connecting from the +5V supply rail to pin 15 of the LCD module is to provide current for the module's LED back-lighting.

IC1 and the selectable DC voltage source operates directly from the 12V DC supply line (via polarity protection diode D5 and of course power switch S2) while the rest of the circuit operates from a regulated 5V rail which is derived from the battery via REG1, a standard 7805 3-terminal regulator.

That's basically it. The only other point which should perhaps be mentioned is that the PIC16F88 micro (IC3) operates here from its internal RC clock, at a frequency very close to 8MHz. A clock signal of one quarter this frequency (ie, 2MHz) is made available at pin 15 of IC3 and is brought out to test point TP2, to allow you to check that IC3 is operating correctly.

Construction

Now that we have the design and operation under our belts, we're ready to move onto the construction.

Unfortunately, though, space has beaten us this month, so the complete constructional details, including the mounting of the project within the special case, will be presented next month.

In the meantime, the parts list is shown opposite so you can start collecting the bits required. Firmware for the PIC micro will also be on the SILICON CHIP website (siliconchip.com.au) next month. SC

Vintage Radio

By RODNEY CHAMPNESS, VK3UG

The Airzone 612 6-valve battery-powered console

Designed in 1938, the Airzone 612 was a 6-valve battery-operated receiver specifically designed for use in remote areas. It's an excellent performer and even after 70 years, the alignment of the set featured here was almost spot on.

HISTORICALLY, most urban dwellers have not been interested in listening to radio stations outside the city they live in. As a result, radio manufacturers made a point of producing small 4-valve mantel receivers for the mass market. They were typically used in kitchens and bedrooms and were marketed alongside the more expensive 5-valve (or more) mantel and console receivers that were popular from the 1930s to the 1950s.

These little 4-valve sets and their larger siblings were mostly mains-operated and were usually quite simple in design. However, their performance was quite adequate for most city users, who tended to use them for background entertainment rather than for serious listening. It's fair to say that the production of 4-valve sets, along with more ambitious receivers in classy cabinets, was the mainstay of radio manufacturing during the valve era.

Rural listeners

Although such sets performed well in city areas, where there were lots of local stations, they were often unsuitable for use in remote rural locations. Many people at that time had no access to mains power, which meant that the sets had to be battery-powered or designed to run from 32V DC lighting plants. This in turn meant that power consumption had to minimised.

Sets designed for use in rural areas also had to be more sensitive. AM radio stations back in the 1930s were not particularly powerful and were often even less so in country areas. That's because commercial broadcast stations were allowed to operate with transmitter output powers of 5kW in capital cities but only 2kW in country areas.

As expected, country stations were located only in those areas where there was enough advertising revenue to make them viable. This meant that many areas had no stations within hundreds of kilometres. Where I lived as a youngster, the nearest station was 3WV which was 145km away, while the next nearest station was about 180km distant. And we didn't live in the outback by any means!

As a result, for many people in rural areas, large outdoor antennas and sensitive receivers were needed to pick up a reasonable selection of radio stations. Fortunately, ABC national stations were allowed to broadcast at higher powers than the commercial stations and so many ABC country stations used 10kW transmitters.

Against this background, some manufacturers marketed sets that were specifically designed for rural listeners. One such set was the Airzone 612, a 6-valve battery-powered console receiver.

The Airzone 612 6-valve set

The Airzone 612 console from 1938 was an impressive receiver, both as an attractive-looking console and as a sensitive battery-operated set for remote country areas. Airzone had been making good receivers right from the beginning of the 1930s and this model really performs well.

As mentioned earlier, receivers designed for the more remote regions of Australia needed to be quite sensitive. They also needed to have good selectivity and to use as little power as possible.

Most receivers of that era used large 45V batteries plus a 2V lead-acid cell to power them. Usually, three 45V batteries were used, to give a high-tension (HT) voltage of 135V. These 45V dry batteries were expensive but with frugal use, would last about one year.

Battery-powered sets were not just turned on and let run all day, as became the habit of those with mains-operated receivers. Instead, they were turned on for particular programs and then turned off again to conserve the batteries. The lead-acid 2V cell would require recharging every month or so and this was usually done at a local garage or radio service shop. However, some owners did work out other ways to recharge this cell, sometimes with disastrous results!

In the Airzone 612, the current drain from the 2V cell is just 0.54A because the valves used mostly have low filament currents. These low-drain valves did not cause any noticeable reduction in performance. By contrast, most battery-operated sets of the era drew around 0.72A of filament current, despite the fact that they only used five valves.

This is the view inside the old Airzone 612 console. A large loudspeaker and a decent baffle ensured good sound levels despite the output stage delivering a maximum output power of just 350mW.

The battery drain on the HT line is 18mA on shortwave and 17mA on the broadcast band. This is a little higher than for many other sets of the era but the Airzone 612 does have six valves compared to five in most other battery-operated sets.

Circuit details

Refer now to Fig.1 for the circuit details of the Airzone 612. The receiver is quite conventional with a 1D5G (V1) as a tuned RF (radio frequency) amplifier. The output from this stage is coupled via another tuned circuit to the signal grid of a 1C7G (V2) which functions as the frequency converter. This stage generates an IF signal that's 456kHz higher than the tuned RF signal.

This IF signal is coupled via a double-tuned IF transformer to a 1D5G (V3) which functions as the first IF amplifier. The resulting signal is then fed via another double-tuned IF transformer to the second IF amplifier (V4). It then goes through another double-tuned IF transformer to the detection and AGC diodes in a 1K7G valve (V5).

Finally, the detected audio signal is fed to the pentode section of a 1F5G (V6) which in turn drives a large (and efficient) loudspeaker via an output transformer.

The Airzone 612 is not just limited to the broadcast band, however. This is a dual-wave receiver and it also has provision for amplifying the output from a turntable pick-up. It features three tuned circuits for the broadcast band and another three for the short-

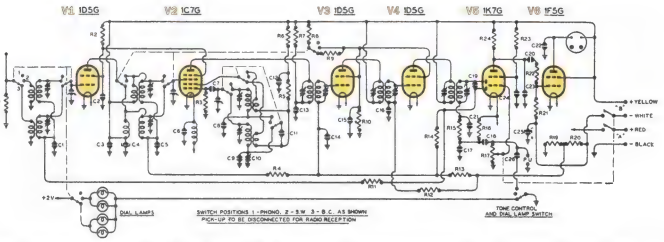


Fig.1: the Airzone 612 is a fairly conventional superhet design employing six valves. It's a dual-band set and was powered from a 2V lead-acid cell (for the valve filaments) and three 45V batteries (to derive a 135V HT supply).

wave band, these being an antenna tuned circuit, an RF tuned circuit and an oscillator tuned circuit (for the converter stage).

The wave-change switch has three positions: phono (record player), shortwave band and broadcast band. This is a 9-section switch, with seven sections involved in switching from broadcast to shortwave. Another section switches the dial lamps so that either the shortwave or the broadcast dial markings are illuminated, while the remaining section alters the screen voltage to IF amplifiers V3 and V4 so that the gain on the broadcast band is less than on shortwave.

When the switch is in the phono position, it removes the screen voltage from the IF valves (V3 & V4) to disable them in this mode.

Another 3-position switch provides a 1-step tone control and controls the dial lamps. In sets such as this, the dial lamps were only switched on to aid tuning and were then switched off to reduce the load on the 2V cell.

A close-up view of the dial scale. The dial lamps are switched so that only the broadcast or shortwave markings are illuminated.

Bias & AGC

The detector diode in V5 has no bias applied to it and commences working as soon as a signal is received. By contrast, the AGC diode is biased to -2V which means that it doesn't start conducting until the IF signal exceeds 2V. This means the set has delayed AGC which is very useful when operating in weak signal areas.

Standing bias is applied to the four RF and IF valves and this is derived from the voltage developed across R19 in the HT- line. In addition, the AGC line applies various amounts of bias to valves V1-V3, depending on the signal strength. The RF valve (V1) receives the full AGC voltage (via R11), while V2 & V3 receive just half the AGC voltage (derived from the junction of resistors R13 and R14). V4 (the 2nd IF amplifier) has no AGC applied to it.

Here's looking at you

Some console receivers of the era looked like they had cabinets made out of wooden packing-cases. Not so the Airzone 612 – its stylish cabinet is well-built by any standard. It features a round escutcheon with the dial-scale in the centre, while the four control knobs are placed along the lower, outer rim of the escutcheon.

This differs from most other receivers which had their controls arranged in a straight line along the chassis.

The clear dial cover in the escutcheon is now showing its age, having yellowed somewhat. However, because it's curved, a replacement is difficult to source.

The chassis and cabinet interior required very little cleaning and as can be seen, the labelling on the chassis is almost as good as the day it was made. By contrast, the cabinet has suffered a number of knocks over the years and requires a lot of work to make it look new again.

Restoring the circuit

Considering it age, the chassis was really in quite good condition although there were inevitably a few problems. First, when it was removed from the cabinet, it was found that the volume control had been replaced at some time in the past and its shaft had been cut quite short. As a result, it was missing its control knob.

An under-chassis inspection also revealed a degree of tampering by someone who clearly didn't know what they were doing. This is a common problem with many vintage radios – the "hero" who is going to restore it attacks it with great gusto, in the process removing many parts which are earmarked for later replacement. Unfortunately, he subsequently cannot remember where everything goes and so parts finish up where they don't belong and the set doesn't work properly.

Finally, after lots of mucking about, our "hero" gives up and sells the set as "a going concern" (which it isn't) to another collector. It's a scenario I've encountered all too often.

Fortunately, this receiver had since come into the hands of a friend of mine

(Marcus) who is capable of restoring old radios. His practice is to replace all the paper and electrolytic capacitors when restoring a receiver and so this was one of his first jobs. Marcus also tested all the valves and found that the 1K7G was faulty. This was replaced, after which further checks were made on component values.

During this process, Marcus discovered that the 1K7G's plate resistor (R24) had been changed from 250kΩ to 20kΩ. The original 250kΩ resistor had been wired to the grid instead of the plate, so it was no wonder the valve was faulty. Valves do not take kindly to significant positive voltages on their control grids.

Another problem concerned backbias resistors R19 & R20. These are actually part of a single tapped wirewound resistor which is bolted to the chassis. This was faulty, again due to the previous restorer, and was replaced with two separate resistors.

Next, the various moving controls and sliding surfaces were oiled and the dial system checked over. The dial mechanism has a flywheel drive which is good for rapidly tuning from one end of the band to the other. Many sets had this function in the 1930s and 1940s and I've usually found them easy to use.

Marcus' next task was to obtain a 230V AC to 2V DC and 135V DC power supply. Fortunately, suitable kits are available commercially and so one of these was assembled and tested. (Note: a design using readily-available parts and with various output voltages will be described in a future Vintage Radio column).

Having completed the power supply, Marcus connected an antenna and an earth (via a 10nF capacitor to chassis) and switched the set on. The result was complete silence, despite the fact that most of the critical parts had been checked and the obvious faults fixed.

It didn't take long to track down the problem. A close inspection soon revealed that the speaker transformer had been replaced at some stage and the speaker cone had also been damaged. Unfortunately though, the flexible wires that connect the voice coil to the speaker transformer had been broken.

This fault was quickly repaired using some flexible wire from a defunct loudspeaker, while the hole in the speaker cone was repaired by gluing a thick paper covering in place. This was the original speaker, so it was worth spending the time to repair it.

The old Airzone's chassis was in remarkably good condition for its age, with all the labelling still intact. Unfortunately, someone had tampered with the circuitry, although the problems were soon sorted out.

Marcus was not happy about the speaker transformer being mounted directly on the speaker, however. The reason for this was simple – if anyone was to remove the speaker plug on the back of the chassis while the receiver was operating, the 1F5G output valve would have no voltage on its plate but full voltage on its screen.

It would not survive this sort of treatment for long and so, despite detracting from originality, Marcus decided to mount the transformer on the chassis, with only the voice-coil leads going to the speaker via the plug.

In fact, it would not have been difficult for Airzone to have corrected this problem. They could have easily wired the receiver so that the HT to the entire circuit was removed if the speaker was unplugged, thus saving the 1F5G from destruction. As shown in Fig.2, the modification is so simple that it makes one wonder why Airzone didn't do this.

It still didn't work

The set was tested again following the loudspeaker repairs but it still refused to work. As a result, the voltages around each stage were checked and this revealed that V1's plate had no

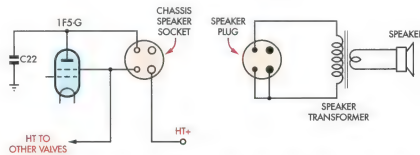
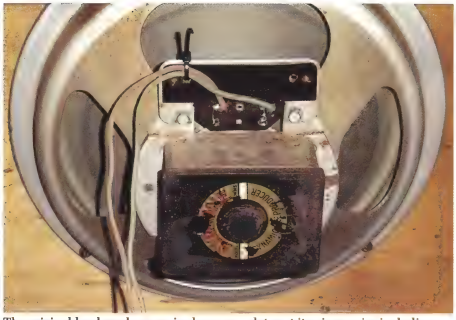


Fig.2: this circuit shows how the unit could have been wired so that the HT to the valves was removed if the speaker assembly was unplugged.



The original loudspeaker required some work to get it going again, including a patch on the paper cone. The flexible wires that connect the voice coil to the speaker transformer had also been damaged and required replacement.

voltage on it. Once again, the cause was simple – an RF (radio frequency) choke in the plate circuit had gone open circuit.

Just why there's an RF choke in this location is a mystery and the circuit certainly doesn't show one. My theory is that it may have been added to overcome some instability. It was replaced with a small resistor-style RF choke but the receiver still refused to work.

It was then found that the earlier "restorer" had wired gangs two and three together at the switch. Once that had been corrected, the receiver came to life and it was possible to tune stations at good volume.

A quick check revealed that the IF alignment was close to optimum, as was the alignment of the front-end stages around valves V1 and V2. This is a tribute to the quality of the components used by Airzone in this receiver. All that was left to do was to replace some defunct dial lamps and fix the volume control.

A switch-potentiometer was used for the original volume control and as the on/off switch. However, because the new power supply had its own on/off switch, Marcus decided to fit an ordinary potentiometer instead.

The shaft on this replacement unit was still too short and so an extension had to be fitted. A brass extension shaft was scrounged from his spare parts bin while a sleeve to join the two was made from some 16mm-diameter round aluminium bar. This was turned down in a lathe and drilled through with a 0.25-inch hole. Finally, two holes were drilled and tapped along one side to accept the grub screws.

At this stage, the technical restoration was complete and the set has now been returned to its owner so that the cabinet can be restored to its former glory.

Summary

This set's performance is superb, with distant stations like 5CK (about 750km away from my location in country Victoria) being heard in daylight at a reasonable level. It only has around 350mW of audio output but this is more than adequate due to the efficiency of its loudspeaker and the use of a decent baffle in the large cabinet.

In summary, it's a set that's well-worth having in any collection. SC

The Fifth National Radio & Phono Fest

By KEVIN POULTER

In a departure from our usual Photo Gallery feature, this month we are publicising a huge vintage radio and phonograph event. Scheduled for September, it will feature a vast range of collectibles for sale and free workshops.

This can be a great opportunity to start or expand your collection, see the best collectables and learn restoration techniques. There is no bigger event in Australia for these collectables.

Vintage radio is so popular that this national event is now staged every two years in the nation's capital. Titled the "HRSA Radio Fest" (previously called the "National Radio and Phono Fest"), it attracts big crowds of HRSA (Historical Radio Society of Australia) members plus members of affiliated groups and an enthusiastic public to Canberra each spring.

In the beginning . . .

RadioFest began in late 2000 when Richard Begbie, a relatively new member of the HRSA, attended their meeting in Sydney. He suggested that with the co-operation of similar groups around the country, there might be room for something bigger – a national event.

And so the first "National Radio and Phono Fest" was organised for September 2001. A church hall was hired but it soon became apparent that it wouldn't be big enough. An adjoining hall was also taken over and by the time the RadioFest doors opened to the public, both halls were jammed with gear for sale. Stallholders and visitors from as far away as Japan were equally enthusiastic about the day and everyone – with the possible exception of the stunned organiser – declared it must happen again.

Of course, its ongoing appeal also has much to do with Canberra's other attractions like the War Memorial, the Film and Sound Archive, the National Museum and the beginning of the capital's annual garden festival. If you get sick of looking at dusty valve technology, there are lots of other things to see and do.

RadioFest offers much more than the usual swap meet. Beyond the large trading halls, there are also workshops by experts on technical, mechanical and restoration matters. A dinner on the Saturday night

provides the chance for radio enthusiasts to get together and share their knowledge and experience.

Because of ongoing space demands, the show was soon moved to University House in the grounds of the ANU (Australian National University) and has since continued to expand. The dinner became a highlight for many, while others eagerly stocked up on rare vintage parts, early phonographs, intriguing radios which tell the story of broadcast radio and must-have sets of the type seen regularly on TV collectors' programs. In addition, films are made of the various workshops and distributed to enthusiasts around the country.

This year it's on again and the anticipated crowd sizes have dictated yet another change in venue, this time to the Kamberra Wine Centre (yes, the spelling is correct) over the weekend from 18-19th September. Moreover, the HRSA has officially taken over the event for what promises to be a bumper Fest. An added feature this year will be a display of some of the best early radio collectables, including many unique items in Australian radio history.

Richard Begbie said the national event had become a huge logistical effort and welcomed the HRSA's involvement in the organising. "I am delighted that the HRSA has taken over this event", he told me. "The Society is its natural home and it's the kind of thing they'll do well. And besides – there'll be more people to do the work!"

Mike Osborne, president of the HRSA agrees. "I've watched the Canberra Fest grow from its beginnings and have personally enjoyed every aspect of its development. It's a great step forward for the society to be taking responsibility for a national event".

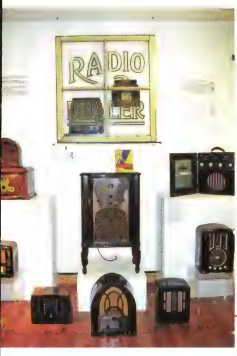
The Kamberra Wine Centre, Federal Highway, Watson ACT is a terrific venue, with good access from the Federal and Barton Highways. If you want to know more, visit the HRSA's website at **www.hrsa.asn.au** and click on "RadioFest" for the location map and dates.

So how do you secure a place at this outstanding event?

If you have something to sell, stall tables are fast running out with just one size left – 1800 x 760mm (6ft x 2.5ft). These are available for $25 each. Stall tables are available to HRSA members and affiliated groups only, however there is still time to join the HRSA, for $35 per year. This fee includes the "Radio Waves" magazine. For stall bookings, contact Richard Elliott on (02) 4846 1096 or email him on **lambdas@optusnet.com.au**

The Sunday entry to the event is $5 per person or $10 for a family (stallholders exempt). The dinner function is $40 per person or $75 per couple. The bar opens from 6:15pm. For bookings, contact John Carr on (02) 6226 3230 or Richard Elliott on (02) 4846 1096; email **lambdas@optusnet.com.au**

Accommodation options range from camping grounds to five star. For details, including distance from venue, contact Richard Elliott. Other queries can be directed to Richard Begbie on (02) 6238 2246; email **rb@bordernet.com.au** **SC**



RadioFest Program

- Sit-down dinner, Saturday 7pm – great entertainment, including a guest speaker. Preview display over pre-dinner drinks.
- Bumper market from 9am Sunday – parts, radios, ephemera.
- Genuinely unique historic items in multiple displays.
- Professionally-presented workshops, including:

(1) The History & Mystery of the Valve.

(2) J. G. Balsillie – The Forgotten Australian Radio Pioneer.

(3) Timber Cabinets – When And How To Restore.

- The HRSA Annual General Meeting (members only) – to be held on Sunday night, with members from all over Australia.

ASK SILICON CHIP

Got a technical problem? Can't understand a piece of jargon or some technical principle? Drop us a line and we'll answer your question. Write to: Ask Silicon Chip, PO Box 139, Collaroy Beach, NSW 2097 or send an email to silicon@siliconchip.com.au

PC-controlled burglar alarm

I have a problem with the PC-Controlled Burglar Alarm. When I am in the arm/disarm menu or in the comms set-up menu, the red LEDs are always off no matter what changes I make to the program. The buttons concerning the strike doors work but the red LEDs remain off whether I arm or disarm the corresponding zone.

The PC Tx/Rx LED works fine; it flashes at varying speeds. I use a laptop with a USB-to-serial interface. Can you please help. (I. P., via email).

● Check the connection between pins 5 & 6 of IC1 to pins 11 & 10 of IC4. Check that IC4 has a +5V supply at pin 16 and 0V at pin 8. Check that the LEDs are oriented correctly. Check the connection from pin 7 of IC1 to the base of Q6 via the 1.2kΩ resistor. Make sure there is a 100kΩ resistor from pin 6 of IC1 to the 5V supply.

Using a 3G modem with the WIB

I have been rather interested in the well-written and explained article on the mysteries that revolve around the Web Server In a Box project. Could this WIB be used somehow with the 3G wireless modems, like the Huawei 169 USB unit, for example?

At present, my 3G modem is through Optus which links to Virgin Blue. I hope you can help me. By the way, this is a great project that could help with remote data-logging and do it in a way that is very economical.

I have been waiting for years for someone to do this. (A. M., Warrnambool, Vic).

● You will need a modem with an ethernet rather than a USB connection to use with the WIB. To be able to use a USB modem, you would need a USB host and the WIB has no hardware support for a USB host as it stands. However, there are 3G wireless modems which have an ethernet connection and these should work with the WIB.

Class-A 20W amplifier question

For my active speaker project, I need to build two 20W class-A stereo amplifiers without the preamps (Silicon Chip, May 2007). Unfortunately, Altronics does not supply the shielded 16V+16V, 160VA toroid transformer separately from the kit (K5125). Could you please indicate if I can use an 18V+18V 160VA toroid, or should I use a 15V+15V 160VA toroid?

I will relocate the transformer to a separate enclosure to stop the electromagnetic field from affecting the performance of amplifier modules. (D. H., via email).

● Assuming you cannot purchase the specified shielded 160VA transformer, your next best approach may be to buy a 300VA 15V+15V toroidal transformer and as you suggest, house it in a separate box. Since the load on the transformer will be less than 100W for the two 20W modules, its output voltage is likely to be close to 16V+16V and therefore the amplifier operating conditions should be much the same.

The bigger transformer should also have less tendency to buzz audibly at the reduced load although it will still radiate the same magnetic field intensity.

Replacing the amplifier modules in an ETI 5000

I am about to build two Ultra-LD Mk.2 amplifier kits (Silicon Chip, August & September 2008) and two new power supply boards. These will replace my ETI 5000 amplifiers and power supply in the same 3-unit case.

Troubleshooting The High-Quality Stereo DAC Project

I've completed the input board of the Stereo DAC (Silicon Chip, September, October & November 2009) and it does not recognise when digital data is being sent through optical or coaxial cable.

After I plug in the optical cable and there is no data transmitted, the yellow LED is on. After I start playing anything, the green LED should turn on but it doesn't.

I've checked whether I have all the parts where they should be and I do not see any problem. Can you please advise how to debug this problem? (R. D., via email).

● The first step is to measure the voltage at pin 15 of IC4 (ATMEGA-48/V) relative to ground (pin 22). If a valid signal is present, it should read close to 0V. If it is around 5V, this means that IC3 (DIR9001) is not receiving a signal. In that case, you should check IC3's power supply (ie, the 3.3V rail) and ensure that it is operating correctly.

If you have an oscilloscope or a frequency counter, monitor pin 13 of IC2 and make sure it is delivering a 3-8MHz square-wave pulse train. If pin 15 of IC4 reads 0V but still no LEDs are lit, then the problem may be with IC4. It could be incorrectly programmed or defective. Check the voltage at pins 5 & 6 of IC4 relative to ground (pin 8). If there is a valid signal present but no audio, pin 5 should read 5V and pin 6 should be at 0V.

If there is a valid signal and audio, pin 5 should be at 0V and pin 6 at 5V. If both are at 0V and pin 15 is at 0V, then the ATMEGA48 is not programmed correctly or faulty.

If you get a reading near 5V at either pin 5 or pin 6 but the yellow and green LEDs are not lit, the ribbon cable connecting the input board to the front panel is probably faulty. Either that or the LEDs are installed backwards.

However if possible, I would like to use the original transformers, except that their secondary voltage is 42V-0-42V AC, as opposed to the 40V-0-40V as recommended for the Ultra-LD amplifier. Would the extra DC voltage be a problem and would it affect the specification of the amplifier. (L. W., Bega, NSW).

- The slightly higher transformer voltage should cause no problems and will lead to a slight increase in maximum power output.

Digital sampling of IR remote controls

I am wanting to monitor and study the output of some infrared remote controls using the IR Remote Control Tester (SILICON CHIP, January 2009) and an oscilloscope.

Unfortunately, my analog scope is hopeless due to the random nature of the output of a lot of remote controls. Obviously, a digital scope is required but I was wondering if there is a cheaper method.

I was thinking that maybe a multimeter with a data logging computer interface, such as those sold by Jaycar or Altronics, would suffice? (J. C., Toormina, NSW).

- Most multimeters with an IRDA computer serial interface have an update rate which is far too slow for decoding infrared remote control protocols.

There are bench meters such as the PicoTest M3510A (which we reviewed in April 2010) that can sample fast enough to decode the infrared protocol. The M3510A can take 50,000 readings per second and typical infrared protocols involve pulses a few

Transistor Voltage Ratings In SC480 Amplifier

I know that the SC480 amplifier (SILICON CHIP, January & February 2003) is an old design but I'm wondering about the reliability of using the 2N3055/2N2995 devices with a ±40V supply as these transistors have a V_{CEO} of only 60V. The full rail voltage swing of around 70V or 80V would be seen by the output transistors.

I have had two failures of the output transistors over the last year and not under full power conditions and suspect they failed due to the V_{CEO} rating of the transistors being exceeded. The TIP35/36C transistors would not have this problem since their V_{CEO} is 100V. (D. D., via email).

- You are the first reader to complain about transistor failures, so we wonder if you have come across some low-spec devices. In fact, the V_{CEO} rating (60V), referring to the transistor's collector-emitter rating with the base open-circuit, is unrealistic, since transistors are virtually never operated in this condition. More realistic is the V_{CER} rating (70V).

Even so, the peak-to-peak swing at the output is less than 60V so unless the amplifier was being driven hard into clipping, the ratings are never likely to be exceeded.

Over the years, the SC480 has proven to be a very reliable design. It is still available as a kit and is very popular

Charge Controller Waveforms Not Quite Right

I have built your Charge Controller For Lead-Acid Batteries, published in the April 2008 edition. You state in your circuit description that the PIC microcontroller delivers a square-wave signal from its pin 9 (PWM) output.

However, as viewed on my scope, pin 9 is delivering something that looks more like a steep-sided sinewave. At the combined emitter outputs of transistors Q2 and Q3, the signal looks like a compromise between a square and a sinewave (sloping sides with flattish tops).

Is this a problem and if so, how can I get a square-wave to appear? I have noticed when the charge controller is in circuit, the battery voltage (measured at the battery) jumps around quite a bit and remains below the default settings of 14.4V for bulk/absorption and 13.8V for float.

Is that to be expected or can the voltage be stabilised at the stated default levels? The charging current is provided by photovoltaic modules. (C. B. Bundagen, NSW).

● The waveforms may be a little distorted from their true square wave shape due to loading on pin 9 when the signal is close to 0V and at the 5V rail when Q3 and Q2 switch on. Similarly, the emitters of Q2 and Q3 may slew rate limit due to the transformer load applied via the series 3.3nF capacitor.

As for the charging voltages, the battery voltage will be higher when charging and lower when not charging as current is switched on and off via Mosfet Q1. This is normal. You can reduce this effect if the 100% charging trimpot (VR1) is set higher than 1V to keep Q1 on during bulk charge.

The voltage is varied depending on temperature and is dependent on the VR4 setting, ranging up to 50mV/°C above 20°C. This may not seem like much but on a hot day at (say) 35°C, the voltage will typically be 0.525V lower for the cut-off and float voltage if VR4 is set for 5V.

hundred microseconds long. However, this meter costs more than some cheap digital oscilloscopes so it doesn't really solve your problem.

The Salae Logic analyser we reviewed in September 2009 is much closer to what you want. At the time, it cost US$149. It plugs into a computer and samples up to eight channels at a sufficient rate for what you want. The alternative is to buy a digital oscilloscope and these are becoming surprisingly affordable.

UHF control system needs solar backup

I recently purchased the 433MHz UHF Remote Switch kits (SILICON CHIP, January 2009). They were easy to assemble and they work perfectly. I thought that I may have been able to adapt them to my needs but I need a little assistance.

With regard to the receiver unit, I need to install it in an area where there is no power supply (eg, garden sprinklers with latching solenoid) and I am using the momentary switching function for three seconds. I did test the receiver on a 9V battery and the whole circuit works OK. The problem here is that the power consumption of 7mA during idle soon depletes the battery.

There are commercial brands of similar design UHF receivers being used in garden irrigation systems and they use a 9V battery. The battery is installed in a very compact receiver case, in a valve box with connection to a latching solenoid.

The valve box, receiver unit and solenoid are remotely located well away from a power supply. The manufacturer claims that the battery will last for up to 12 months and they use the same latching solenoid as mine.

I am hoping that you can advise me of an enhancement so that I can obtain the same performance. (N. S., via email).

● Unfortunately, the receiver was not designed for low-power consumption as the UHF receiver needs to be permanently on so as to detect a signal from the transmitter at any time. Without drastic circuit and software changes, the circuit is not suited for low-power use.

Garden irrigation systems can be designed for low current consumption whereby power is applied to the receiver once every 20s (say). The transmitter would be designed to send a signal for longer than this period when a change from the receiver is required. By doing this, the receiver receives the signal even if it is left unpowered most of the time.

If you wish to use the existing UHF receiver, then perhaps a 12V SLA battery and a solar cell charger could be used for the supply.

Batteries for a vintage portable radio

I recently bought a Healing Golden Voice portable radio. It has no batteries and I don't know what voltage it is. Is there any way of connecting a suitable power supply so I don't have to use batteries?

If not, where do I buy batteries to suit? It has two 3-pin plugs and one 2-pin plug. I did get some information from the Victorian Museum but am not sure how to interpret it. (T. V., Mt Martha, Vic).

● As copied from a reply you received from the Victorian Museum, the supply voltages for the radio are 1.5V and 90V. The 2-pin plug plugged into the 1.5V "A" battery, while the two 3-pin plugs connected to a pair of 45V "B" batteries. The "A" battery was usually a long rectangular box with a number of 1.5V cells in parallel and the valve heater current drain was 300mA.

The load on the "B" battery was 13mA. The "B" batteries would have been Eveready Minimax type 482, while the "A" battery would have been a type 742 or 745. These have not been made for many years.

The 1.5V rail could be supplied using an alkaline D cell, with a D cell holder. The 45V at 13mA can be obtained by connecting five 9V batteries in series using battery snap connectors but they would not last long at a current of 13mA.

We have not published a power supply for such a radio although if there was significant interest it would be a relatively simple exercise.

Dremel engraver tool repair

I have been asked to repair a Dremel engraver tool and it appears to have a Triac or thyristor in it as part of the speed control. Do you know what

Problem With Programmable Ignition System

I have constructed the Programmable Ignition System, together with Knock Sensor, Ignition Coil Driver and Hand Controller (SILICON CHIP, March, April & May 2007). The problem is that as soon as power is connected, the unit goes straight into the oscillating mode.

Using the Hand Controller, I can turn the oscillation off OK and it will stay that way while power is connected. However, as soon as I remove the power and power up again, the oscillation starts. This occurs regardless of the position of LK1.

In addition, the display on the Hand Controller often shows incorrect characters, eg, "W" instead of an "S", an "M" instead of an "I", a "]" instead of a "Y". The characters substituted are four apart on the ASCII table, suggesting one bit is being set when it shouldn't be.

I have carefully checked the main board and the Hand Controller board for soldering errors, checked resistances between data lines etc and cannot find anything wrong. I believe there is an error in the preloaded software of the PIC controller and I need to know how I can get it fixed. (W. H., via email).

- The oscillator mode can be set to off by powering up, turning off the oscillator and then changing the edge sense from the current setting of either high to low or low to high. You then change the edge sense back to the original setting again. Doing this will keep the oscillator off at power up.

Changes to the display characters indicates interference or a connecting cable for the Hand Controller that is not earthed. Try earthing the shell of the cable. Also make sure the lead is well away from the high-tension wiring of the ignition.

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3-pin TO-220 device would be used as the Triac or thyristor and would the electric motor actually run OK with the full 240V on it, even though it would spin its head off? (P. H., via email).

- If your Dremel is a 240V tool with in-built speed control, the motor itself is likely to be rated to run at 180VAC. Running it at 240V may blow it. Without more information about the devices used in the speed control, we cannot nominate a substitute.

GPS module availability

I have two questions in reference to the GPS-Based Frequency Reference (SILICON CHIP, March 2007). The Garmin GPS 15L receiver module specified is no longer available. Is there an alternative? Is it possible to use a GlobalSat Technology EM-408 GPS module in its place? (R. H., via email).

- It would appear that the Garmin 15L receiver module is no longer available in Australia, even though Garmin still has it listed as a current product on their US website. We contacted the local office of Garmin, which advised that head office is no longer making it available here. However, you should still be able to order one online, from one of the overseas distributors.

The GlobalSat Technology EM-408 is unfortunately not suitable for use in the GPS Frequency Reference, as it does not provide a 1pps output.

Amplifier for a knock detector

I am currently working on a project to make a listening device using the Champ amplifier (SILICON CHIP, February 1994) and the Pre-Champ (July 1994) connected to an electret mic insert.

The purpose of this project is to make a knock detector to use while

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The Virtues Of Non-Inductive Resistors

I am building the Studio 350 Power Amplifier (SILICON CHIP, January & February 2004) from individual parts (not a kit) and have a question about the eight 0.47Ω and one 6.8Ω 5W ceramic wirewound resistors. Would there be any advantage or disadvantage in using non-inductive 5W ceramic resistors in this module?

Also, regarding the 330pF, 68pF and 10pF ceramic disc capacitors, would there be any advantage or disadvantage other than cost in using silvered mica capacitors in the Studio 350? With the 12nF 100V MKT polyester capacitor, could a 10nF or a 15nF be used instead without having any problems? (P. C., Whitebridge, NSW).

● There is no disadvantage in using non-inductive resistors in any audio circuit but in the case of this amplifier there could be an advantage. In the past, we have specified paralleled carbon resistors instead of 5W wirewound emitter resistors, in two instances.

The first was in another "life", in the design of the Playmaster 60/60 ("Electronics Australia", May, June & July 1986). In that case, the complete stereo amplifier was on one very large PC board which included all the low-signal connections from the rear panel to the front-panel selector switch via unshielded copper tracks. Hence, it was important to keep any signal radiation from the amplifier's emitter resistors to a minimum.

The second instance involved both versions of the Ultra-LD Stereo Amplifier (SILICON CHIP, March & May 2000 and November 2001 to January 2002). These used ribbon cable for the input signal wiring to the selector switch and again, we wanted to minimise radiation from the amplifier's output stage resistors.

So unless you have unshielded low-level signal wiring in the same case as a big power amplifier, non-inductive resistors should not normally be required. There is more to the story, though. First, some much older amplifier designs presented in other magazines were specified with non-inductive emitter resistors in the output stages to minimise the effects of inductance on the non-linearity of the transfer curve, ie, inductive resistors apparently made crossover distortion worse. We cannot remember the specifics but it may have been more applicable to power Mosfets than to bipolar transistors.

More recently, readers will be aware that we have done quite a lot of work with the PC board layout of recent amplifier designs to minimise or cancel the radiation of the magnetic fields produced by class-B output currents into the small signal stages. The best and most effective example of this is the double-sided PC board for the Ultra-LD Mk.2 Amplifier module featured in the August & September 2008 issues. In that case, we did not try the effect of substituting non-inductive emitter resistors. Possibly, we should have and we may try it in the future.

So with respect to the Studio 350, it is possible that non-inductive resistors could reduce the rise in harmonic distortion at the higher frequencies.

As far as the capacitors are concerned, the 68pF unit must be rated at 250V or higher. The dielectric is unimportant. The 12nF value is not critical; use 15nF if that is more easily obtainable.

tuning vehicles. I have made the kit and it works well. However, I would like to improve it by filtering out the frequencies I don't need.

I was planning on making a band-pass filter and adding it to the circuit but after some research I noticed there are high and low-pass filters in the Pre-Champ. Can I change the value of the capacitors and resistors to roll-off all values outside of 5-10kHz? (J. W., via email).

● The filters can be changed. Use a 330nF capacitor instead of the 22µF in series with the 100Ω resistor for a high-pass filter at 5kHz. The .0015µF (1.5nF) capacitor across the 2.2kΩ resistor can be changed to 6.8nF to give a low-pass filter at 10kHz.

Further roll-off below 5kHz can be achieved by changing the 0.1µF capacitor (100nF) at the input of the amplifier to a 560pF ceramic capacitor.

Notes & Errata

Digital Audio Signal Generator (March-May 2010): there is a bug in the firmware. If the default sample rate is changed from 48kHz (ie, settings are written to Bank 0 after the sample rate is changed) then the generator will fail to start up.

The solution is to reflash the dsPIC microcontroller (IC4) with a new version of the firmware (0420310C.hex). This revised firmware can be downloaded from the SILICON CHIP website.

Dual Tracking Power Supply (June-July 2010): the labels for V± and I_{lim} were swapped on the front panel artwork. Updated front panel artwork has been provided to the kit suppliers and is now available on the SILICON CHIP website.

In addition, some constructors have found that VR7 has insufficient range to properly trim the V± reading. In this case, increase the value of its 68Ω shunt resistor or remove the shunt resistor entirely.

GPS-synchronised clock queries

I built the GPS Clock (March 2009) and I have a couple of queries. When testing the DC converter output voltage before installing the EM-408, the start-up LED flashed once, then twice and the converter gave a voltage of 3.27V. However, this voltage did not cut out after two minutes as stated in the text and was still there after one hour. Why would that be?

In addition, 3.27V seems a little low. How can I increase this to 3.3V or is it OK?

The diagram of the EM-408 connections in Fig.1 seems to redrawn from the Users Manual but with the pins in the high position, which would indicate that the unit is mounted the other way up to your article. Consequently, the

. . . continued on page 103

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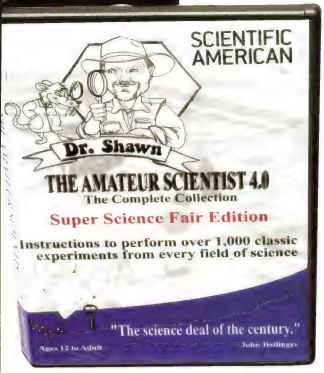

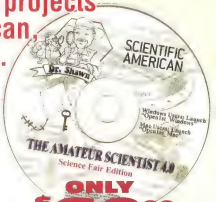

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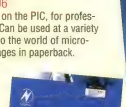

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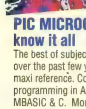

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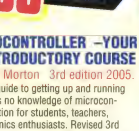

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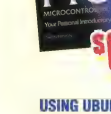

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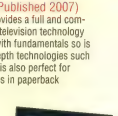

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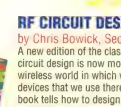

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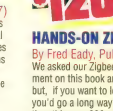

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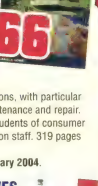

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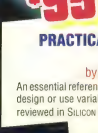

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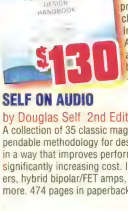

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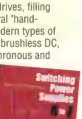

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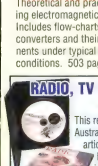

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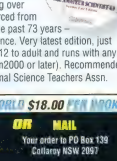

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Ask SILICON CHIP – continued from page 98

numbering does not align with the PC board, ie, pin 5 (Vcc) should be on the left of the diagram. The connections to the PC board seem correct, as in Fig.2. Am I correct? (N. U., via email).

● The cutout on initial start-up was subsequently changed to "forever" rather than the two minutes mentioned in the article. The reason for this is that from a dead cold start (ie, the module has not been used for many months), it will take the module up to 12 minutes to receive a complete set of satellite position data before it could report "ready".

This issue only applies to the first start-up of the clock. On a normal synchronisation (while the clock is running), the micro will now wait for four minutes before declaring "no signal". It will then will retry 10 more times with a 4-hour gap between repeat attempts.

A supply of 3.27V is fine and is well within tolerances. The module will happily run at anywhere from 3.1V to 3.5V.

Fig.2 is correct – the lefthand wire of the module (viewed from the top), which is pin 5, should go to the lefthand solder point on the board (Vcc). The EM-408 pin diagram on Fig.1 is shown with the module upside down (the PC board designation is actually the EM-408's board).

Unnecessary mods to Schoolies amplifier

I have recently assembled a pair of 20W Schoolies amplifier modules. (SILICON CHIP, December 2004) and I believe there is a small design problem with your additional components that differ from the manufacturer's data sheet.

I made some measurements because the speaker protection unit I have started to activate. I discovered that 1.7V was hanging off the output. When I removed your additional components that voltage rail imbalance corrected itself.

These are the changes I made: (1) 10Ω resistor replaced with wire link; (2) 330pF capacitor removed; (3) 22μF capacitor replaced with what I had, a 100μF 25V, for AC grounding; and (4) 1kΩ resistor in series with pin 1 replaced with wire link.

I also removed or bypassed the 2.2μF 16V capacitor from the circuit. Now let's get to the Zobel Network: it's most certainly not working for these speakers and the 1Ω 1W resistor has been removed.

This amplifier is now starting to sound much better. With some good-quality filter capacitors in the power supply and a good-quality transformer, it will be a lot better then when I started. You can always improve on a design. (R. M., via email).

● None of your modifications will make the amplifier better or improve its sound quality. Removing the 2.2μF input capacitor means that any residual DC from your program source will be coupled though the amplifier to the speakers – that may be why your loudspeaker protector is operating.

Removing the 1kΩ and 330pF capacitors will make the amplifier more prone to RF breakthrough and certainly will not improve the audio response – it's already flat to 100kHz.

The original article explained the reason for the inclusion of virtually every component in the circuit – we would not have included them if they weren't necessary. In fact, making arbitrary alterations to any amplifier circuit will generally cause the performance to be worse.

Unless you have the test gear to check the effect of any alterations, you are working in the dark. Our suggestion is that you restore everything to the original circuit. SC

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